GROWING A BACKYARD GARDEN FOR HEALTH AND WELLBEING: A PUBLIC HEALTH NURSING BROCHURE

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ABSTRACT

A backyard garden may be an option for families concerned about healthy eating, food sensitivities, and food security. Despite this, backyard gardening is not a topic that nurse researchers have studied and there are few health promotion resources to support urban agriculture. The purpose of this project was to develop a brochure for novice gardeners on how to establish an urban backyard garden to meet their dietary needs. Specific objectives for this project were to identify and summarize professional and lay literatures on urban, backyard gardening in climate Zone 5b (Peterborough, Ontario) and to create a multimedia-friendly brochure for novice gardeners. This thesis consists of a literature review on gardening, nutrition, and the use of brochures as a knowledge translation tool. The Canadian Index for Wellbeing (CIW) and Lewin's Three-Step Model for Change provided the conceptual framework for project. The methods chapter describes how the information was gathered and analyzed, and the findings chapter summarizes information to guide and support a family in growing their food. The final chapter includes a discussion on food security and household food self-sufficiency and their relationship to health, and the implications for nursing practice, nursing, education, and nursing research.

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LIST OF ABBREVIATIONS

AACODS	Authority Accuracy Coverage Objectivity Date Significance
Ca	Calcium
CHN	Community Health Nurses
CHNC	Community Health Nurses of Canada
CIW	Canadian Index of Wellbeing
Cu	Copper
Fe	Iron
GMO	Genetically Modified Organism
HAS	Haute Autorité de Santé
K	Potassium
Mg	Magnesium
Mn	Manganese
N	Nitrogen
PFHT	Peterborough Family Health Team
PPHU	Peterborough Public Health Unit
P	Phosphorus
S	Sulphur
USA	United States of America
USDA	United States Department of Agriculture
Zn	Zinc

CHAPTER 1. INTRODUCTION

1.1 Defining the Issue

Food self-sufficiency is a concern for many worldwide. The concept of food self-sufficiency is related to, but distinctly different from, the concept of food security (Clapp, 2017). Food self-sufficiency is often cited as a solution for food insecurity in regions where this is an issue (Clapp, 2017). Still, this focus is misguided as food self-sufficiency does not necessarily guarantee food security within a particular country and may allow for political priorities ahead of economic efficiency (Clapp, 2017). The topic of food self-sufficiency appeared at the forefront of discussion in 2007 when the price of food increased in several countries (Clapp, 2017).

The definition of food self-sufficiency by the Food and Agriculture Organization Food and Agriculture Organization, 1996) is "…the extent to which a country can satisfy its food needs from its own domestic production." On a smaller scale, a definition of household food self-sufficiency is when food obtained at the household level is not purchased (Karki, et al., 2015). The question remains, if it is possible for a family to achieve household food self-sufficiency and the degree to which that is possible.

In some communities in Western countries, there is concern about the rising rates of malnutrition, low vegetable and fruit consumption, lack of access to grocery stores, and rising obesity rates (Carney, et al., 2011; Conk & Porter, 2016). As per Canada's Food Guide, eating a proper diet, with half of the food consumed being vegetables and fruits, can help combat chronic health issues such as obesity, type 2 diabetes, heart disease, and some cancers (Health Canada, 2019).

As the population ages, there is an increasing need for action to reduce chronic health challenges, to improve exercise and social connectedness, and to create opportunities for mental wellness. Children require stimulation through their senses and their movement to learn, grow, and reach developmental milestones (Ryan-Krause, 2018). Throughout the human lifespan, there is a need for mental and physical stimulation, including older adults. Tse (2010) reported that living in a nursing home causes patients to experience social isolation and less physical activity. Opportunity for increasing vegetable and fruit consumption, increased activity, and improved mental stimulation and social connectedness can all be achieved with gardening.

1.2 Model Case

The following scenario describes how the use of pesticides can influence the health and wellbeing of families. Assistance can be available to families by using education and knowledge in growing healthy and nutritious food without using unwanted pesticides.

A family of four (mother, father, and two children, aged 6 and 4) in Peterborough, Ontario, has been buying all the food that they consume at the local grocery store for ten years. The 4-year-old has been experiencing stomach aches, abdominal pain, and vomiting for several months. Her parents take her to the family doctor, who determines that she has been experiencing probable food intolerances. Throughout the process of elimination that involves many visits to the doctor and diagnostic testing, the healthcare team decided that she has a food intolerance to commonly used pesticides found in the vegetables and fruits that she consumes from the grocery store. Her parents are concerned because they know that a proper diet, according to Canada's Food Guide, needs to include servings of vegetables and fruits daily with each meal. They do not know how to keep their child safe from harmful pesticides. Eating exclusively organic foods can be prohibitively expensive, so the family decides to plant a

vegetable and fruit garden to control the chemicals on the food grown and the chemicals in the soil while also reducing expenses for the family. The parents seek knowledge about gardening for food from the library, the internet, and gardening friends.

The family doctor also suggests a consultation with a dietician employed by the Peterborough Family Health Team (PFHT) and consult the Peterborough Public Health Unit (PPHU) to speak to a community health nurse. The child's parents made initial contact with the PFHT dietician, and the office booked the family for an appointment to discuss health concerns. The dietician was able to educate the family regarding food sensitivities, the benefits of eating organic food, and how gardening to procure fresh produce that is safe for the entire family to eat. The dietician also provided the family with a brochure on gardening for health and nutrition to limit pesticide use as a supplementary teaching tool. The family was able to take all the information and transfer it to the gardening practice. The PPHU community nurse provided the family with information about safe food handling and cooking classes to help the family prepare nutritious food from their garden that the family enjoyed. The children learned to assist the parents with the garden, and the family was able to take greater control of their health and nutrition and the child's symptoms of food intolerance resolved as long as she ate food from the garden.

1.3 Knowledge Gaps

Although there is growing public interest in backyard gardening, it not a topic that nurse researchers have studied and there is a lack of health promotion resources on urban agriculture. There is little research on the best way for families to incorporate gardening into their daily lives to increase vegetables and fruits and how best nurses and other healthcare providers can facilitate gardening. Time to garden and the expensed involved are well defined in the literature. Reliable

information is needed on how to prevent pests from eating the crops in an urban setting without using harsh pesticides. There are questions about the seeds or plants to be planted at the appropriate time of year to produce food for year-round consumption in cold climate zones. Furthermore, the use and feasibility of greenhouses are unknown. With so many questions, additional information can assist in understanding the extent to which backyard gardens can help families advance toward household food self-sufficiency and what nurses can do to assist. While this project does not address all knowledge gaps, it is intended as a starting point for families new to gardening.

1.4 The Canadian Index of Wellbeing (CIW)

Population health and wellbeing are of fundamental interest to community health nurses. The Canadian Index of Wellbeing (CIW) defines wellbeing as:

> "The presence of the highest possible quality of life in its full breadth of expression focused on but not necessarily exclusive to good living standards, robust health, a sustainable environment, vital communities, an educated populace, balanced time use, high levels of democratic participation, and access to and participation in leisure and culture."

The CIW (2016) measures wellbeing in Canada across eight domains: community vitality, democratic engagement, education, environment, healthy populations, leisure and culture, living standards, and time use. The application of this framework is an ideal tool for the framing and production of the brochure as the brochure addresses the following domains of wellbeing: community vitality, healthy populations, leisure and culture, living standards, and time use.

Community vitality reflects the presence of active and inclusive relationships among individuals and organizations in fostering collective wellbeing and the quality of life within a community (CIW, 2016). It focuses on what is occurring in neighbourhoods, personal safety, and

community activity involvement (CIW, 2016). The brochure is intended to promote community vitality by supporting people to start gardens on their property within their neighbourhoods. Gardening is commonly an outdoor activity and provides opportunities for community members to meet their neighbours, avoiding social isolation.

The CIW also focuses healthy populations, which includes physical, mental, and social wellbeing of the population; life expectancy; lifestyle and behaviours; and access to healthcare. (CIW, 2016). The brochure has the potential to improve health by encouraging the consumption of vegetables and fruits, aiding with food self-sufficiency, avoiding pesticides, increasing outdoor exercise, getting to know neighbours, increasing family bonds, improving mental health, and other health benefits.

Leisure and culture focus on how recreation practices contribute to wellbeing (CIW, 2016). Gardening can be a form of recreation by allowing people and families to spend time in their gardens, increasing physical and mental health, creating prospects for socialization and relaxation, and learning new things about the garden. An aim in developing this brochure was to assist users in finding a leisurely practice that yields positive health and well-being benefits.

Living standards are related to things such as income, food security, and affordable housing (CIW, 2016). This brochure can help with food security by equipping individuals to produce inexpensive, nutritious food from the privacy of their own yard. It is designed to help community members improve living standards by providing healthy, accessible food.

The time use domain considers how community members use time (CIW, 2016). This brochure takes time use into account by acknowledging that people need to spend time on a project that is beneficial to wellbeing and yields positive results. Establishing and maintaining an

urban garden for food production can impact a person's time while positively influencing health and well-being.

The brochure addresses several of the CIW framework components. The application of this framework guided brochure development by providing goals for wellbeing and a roadmap for how the brochure could help the public. The brochure can enhance current nursing knowledge through the lens of the CIW framework.

1.5 Lewin's Three-Step Model for Change

Lewin's Three-Step Model for Change states that people or groups of people must change in order to respond to an ever-changing environment, thereby maintaining balance (Lewin, 1947; Wojciechowski, et al., 2016). The three steps in the change process are: unfreezing, changing/moving, and refreezing (Lewin, 1947; Wojciechowski, et al., 2016). Unfreezing occurs when a system recognizes that change is necessary. This challenges the *status quo* and disrupts current ways of thinking and behaving, which precipitates a crisis (Lewin, 1947; Wojciechowski, et al., 2016). The uncertainty created in the unfreeze stage motivates individuals to look for new ways to do things and re-establish balance. They begin searching for solutions by brainstorming, retooling, coaching, or training (Lewin, 1947; Wojciechowski, et al., 2016). Refreezing refers to the return of equilibrium with the implementation of new habits and new resistance to change (Lewin, 1047; Wojciechowski, et al., 2016). This model offers some insight into how people and organizations change. With respect to the establishment of a backyard garden to improve health and wellbeing, unfreezing refers to the client recognizing that there is a problem with their diet and beginning to seek alternatives. Changing/moving refers to the client looking for information about their options for improving their diet by growing their

own food and using the brochure for guidance. Refreezing refers to the client learning the skills of gardening and incorporating it into their daily lives.

1.6 Purpose and Objectives

The purpose of this project was to develop a brochure for novice gardeners on how to establish an urban backyard garden to meet their dietary needs. Specific objectives for this project were to identify and summarize professional and lay literatures on urban, backyard gardening in climate Zone 5b (Peterborough, Ontario) and to create a multimedia-friendly brochure for novice gardeners.

1.7 Relevance and Significance

Household food self-sufficiency may be an option for families concerned about food sensitivities related to pesticides and other additives in processed food. Achieving food self-sufficiency using a backyard garden is not a subject that researchers – particularly nurse researchers - have previously studied, even though it may help with many chronic health conditions. Nursing research on achieving household food self-sufficiency through a backyard garden will help 1) identify the tools and land required for families to maintain a backyard garden, 2) develop the knowledge related to properly sustain a supply of food in all seasons and climate; 3) provide information for families about healthy food choices, 4) contribute to public health nursing knowledge by providing a brochure as a tool to improve nutrition and health.

An informational brochure is a commonly used health promotion tool to educate people on a topic and guide and facilitate health teaching (HAS, 2008). Healthcare brochures provide accurate, precise, succinct, and readily accessible information based on factual scientific evidence (HAS, 2008). The information must be easy to understand, relevant to the issue, and

supplement verbal health teaching. Brochures could be produced in multiple formats to reach a broader audience.

1.8 Pamphlets vs Brochures

Pamphlets and brochures are different in nature and purpose. Pamphlets are smaller than brochures, unbound, and convey a single idea (Modern Litho, 2020). They are sometimes referred to as "leaflets" (Modern Litho, 2020). On the other hand, brochures are bound, consist of multiple pages, and therefore contain more information (Modern Litho, 2020). A brochure was chosen as the primary output of this project because more information can be presented in a brochure than in a pamphlet.

1.9 Key Terms

Several key terms are used throughout the thesis.

Community Gardening: Group gardening of fresh fruits and vegetables, in which community members provide advice and support to help overcome challenges and all receive the benefits the gardening project offers (Carney, et al., 2011).

Food Security: "...food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life." (Food and Agriculture Organization, 1996).

Food Sensitivities: Food intolerance or food sensitivity occurs when a person has difficulty digesting a particular food. Such sensitivities can lead to symptoms such as intestinal gas, abdominal pain or diarrhea (The American Academy of Allergy, Asthma, and Immunology, October 2019).

Food Sovereignty: The autonomy of communities to have access to culturally appropriate healthy food and is produced using ecologically appropriate and sustainable methods (Riches, 2018).

Household Food Self-Sufficiency: "…food produced at the household level, not including purchased food…" (Karki, et al., 2015, para. 2)

1.10 Summary

Gardening has multiple health benefits beyond nutrition, including physical exercise and social cohesion (Gray, et al., 2013). Nurses and other health care providers can support families to develop new knowledge and skill and gain a sense of control in uncertain times. This project consists of a literature review on gardening, nutrition, and the use of brochures as a knowledge translation tool. The methods chapter describes how the data were gathered, analyzed, and the findings chapter summarizes information to guide and support a family in growing their food. The final chapter discusses the more significant picture issues of food security and household food self-sufficiency and their relationship to health, and the implications for nursing practice, nursing, education, and nursing research.

CHAPTER 2. LITERATURE REVIEW

This chapter reviews the literature on topics related to home gardens to promote household food self-sufficiency for families with allergies or sensitivities to agriculture sprays. The themes are (1) food self-sufficiency, (2) nutrition and chronic conditions, (3) gardening through the lifespan (4) pesticides and organic food, (5) urban gardening community, (6) growing zones, (7) Community Health Nurses, and (8) brochures as tools. This information is vital for understanding the importance of gardening for families with special needs.

2.1 Food Self-Sufficiency

Food self-sufficiency is a cause of anxiety for numerous individuals across the globe. The establishment of urban gardens for food self-sufficiency may address issues pertaining to families having enough food and potential financial or social complications in urban settings (Gray, et al., 2013). An urban garden can be a cost-effective way to improve health, and contribute to food self-sufficiency (Gray, et al., 2013). Many Canadian citizens experience food insecurity, but most do not access food banks (Henderson, et al., 2017). Home gardens can be an alterative and address issues such as low fruit and vegetable consumption, lack of access to grocery stores, obesity, malnourishment, and food insecurity (Conk & Porter, 2016). Research on the economic factors associated with backyard food production demonstrates that economic factors play a significant role in the ability to grow produce, and the ability to grow produce enhances the economy of a community (McFadden, et al., 2016; Gray, et al., 2013; Ford, et al., 2013; Ivanov, 2016; Kolodinsky, et al., 2017; Henderson, et al., 2017; Lamalice, et al., 2018; Hunold, et al., 2017; White & Brown, 2010; Amadi, et al., 2016; Smith & Patrick, 2011). Communities with few employment and economic development opportunities are often food insecure, and their members can suffer chronic dietary deficiencies (Ford, et al., 2013). Growing

food in a backyard garden can empower families and communities to control food production and spend less money on commercially grown food.

2.2 Nutrition and Chronic Conditions

Home gardens have many health benefits. A recurring theme in the public health literature concerns proper nutrition, and the recognition that locally produced food is beneficial for appropriate nutrition. Gardening increases the consumption of vegetables and fruits and provides a diversity of dietary produce (Kolodinsky, et al., 2017; Gray, et al., 2013; McLain, et al., 2013; Lovell et al., 2014; Henderson, et al., 2017; Taylor & Lovell, 2013; Carney, et al., 2011; Ostry & Morrison, 2013; Kortright & Wakefield, 2011; McMahan, et al., 2014; Hunold et al., 2017, Laubert, 2017; Bishop, 2014; Linnell, et al., 2014; McAleese & Rankin, 2007; DeFries, et al., 2015; Evans, et al., 2017). Studies on the health and wellbeing of children and the effects of poor nutrition report that backyard gardens enable children and families to consume healthier food (Kolodinsky, et al., 2017; Carney, et al., 2011; Kortright & Wakefield, 2011; Laubert, 2017; Bishop, 2014; Linnell, et al., 2014; McAleese & Rankin, 2007). This increase in the consumption of vegetables and fruits is associated with healthier citizens and healthier communities (Kolodinsky, et al., 2017; Gray, et al., 2013; MacRae et al., 2010; Lovell et al., 2014; Taylor & Lovell, 2013; Carney, et al., 2011; Ostry & Morrison, 2013; Kortright & Wakefield, 2011; McMahan, et al., 2014; Conk & Porter, 2016; Laubert, 2017; Bishop, 2014; Linnell, et al., 2014; McAleese & Rankin, 2007; Seidelmann, et al., 2018; Evans, et al., 2017).

Seidelmann et al. (2018) found an increase in the consumption of vegetables and fruits grown in a backyard garden improved health and longevity (Seidelmann, et al., 2018). Both too little and too high carbohydrate ingestion bestowed a considerably higher mortality risk than the moderate intake of plant-based carbohydrates (Seidelmann, et al., 2018). North American

children are experiencing an increased rate of poor nutrition, sedentary lifestyles, obesity, and diet-related diseases (McAleese & Rankin, 2007; Ostry & Morrision, 2013). Learned eating patterns in childhood tend to continue into adulthood (McAleese & Rankin, 2007). At the same time, however, parents reported difficulty with affording vegetables and fruits when greasy, unhealthy food is cheaper, and children grow to crave unhealthy food over healthier alternatives (Ford, et al., 2013).

The newest version of Canada's Food Guide (Health Canada, 2019) eliminated "servings" as suggested amounts of each food group to be consumed daily. Canada's Food Guide also removed milk and milk products and meat as specific categories from the daily recommended food, replacing them with "protein foods." According to Canada's Food Guide (2019), eating appropriate proportions of vegetables and fruits, grain products, and protein foods will help meet an individual's daily needs of vitamins, minerals, and other nutrients. The recommended proportions of food groups will reduce the risk of obesity, type 2 diabetes, heart disease, some cancers, and osteoporosis and assist with general wellbeing and vitality (Health Canada, 2019).

Canada's Food Guide recommends that people should eat plenty of vegetables and fruits, such that half of the food on a person's plate should be fruits and vegetables, and one-quarter of the food should be whole grains (Health Canada, 2019). Canada's Food Guide also recommends that one-quarter of the food on an individual's plate be protein-rich (Health Canada, 2019).

How much of Canada's Food Guide recommendations can be self-produced for a family of four? The answer to this question will be dependent on the types of food that can be grown in different hardiness zones, climates, space requirements, and potential yields. There are also questions about how changing seasons alter nutrition, garden maintenance, and food storage challenges for families who produce fruit and vegetables in the warmer months for preservation

for the colder months. Gardeners may ask what produce is nutrient-dense and takes the least amount of space to grow.

Sometimes food insecurity is associated with cardiovascular disease, obesity, lung disease, hypertension, diabetes, and cancer (Charkhchi, et al., 2018). Diabetes, in particular, appears to be associated with food insecurity, possibly because diabetes requires a more vital adherence to a healthier diet rather than medications, and food insecurity causes higher stress levels leading to elevated cortisol, which causes an increase of adipose tissue (Seligman, et al., 2009). As food insecurity rises with the escalation of health problems, the only apparent effective intervention for the individual comes from family or the government (Charkhchi, et al., 2018). Government programs aimed at alleviating financial hardships with families with food insecurity have been efficacious in improving nutritional consumption (Seligman, et al., 2009). People with chronic conditions tend to be poorer and consume increasing amounts of highly processed food (Seligman, et al., 2009). Devoid of outside interventions, food insecurity will continue in individuals with chronic illnesses. Skills for backyard gardening may help to address the needs of families with chronic health conditions. This is important for nursing practice because if one of the underlying causes for chronic illnesses is food insecurity, giving information about establishing a backyard garden might, at least partially, alleviate these issues. Chronic illness sufferers may benefit from a diet with fresh, nutritious, low-cost food. This information guide can serve the public and hopefully improve the lives of those in the community.

Gardening has other health benefits, in addition to nutrition. Gardeners viewed growing food in gardens to relax, promote health, and family activity (Lamalice, et al., 2018). Backyard gardens also confer benefits related to wellbeing, monetary savings, social connectedness, and networking (Gray, et al., 2013). Home gardening can strengthen relationships when families

work together toward a common goal (Carney, et al., 2011). Gardeners also give a considerable portion of the homegrown food to other people to eat, thus increasing the benefits of gardening to others in a community (Conk & Porter, 2016).

2.3 Gardening Through the Lifespan

Backyard gardening can increase consumption of fresh vegetables and fruits and serve as a means for multiple wellness outcomes. The health and wellbeing of individuals across the lifespan can be positively impacted by gardening (Buck, 2016). The increase in the consumption of vegetables and fruit for children who learn to garden is one significant connection, but there are many others (Buck, 2016; Ryan-Krause, 2018). Children who grow up growing food and eating food from a garden tend to continue this practice into adulthood (Ryan-Krause, 2018).

Beginning in infancy, gardening can aid in child development by activating the senses, such as looking at the colours and shapes of the plants in the garden, smelling the scents of the garden, hearing the insects and birds, and feeling the vegetation and dirt on the skin (Ryan-Krause, 2018). When children start walking, the exploration increases to aid in small muscle coordination (Ryan-Krause, 2018). For children afflicted with behavioural or developmental delays, gardening presents practical, non-academic tasks in a peaceful area (Buck, 2016). Gardening creates a sense of environmental awareness in children that follows into adulthood (Ryan-Krause, 2018). A garden is an area for leisure, recreation, social communication, play, and activities for all ages (Ruck, 2020; While, 2020).

The evidence suggests that gardeners experience fewer falls and improved gait than non-gardeners (Buck, 2016; While, 2020). There is no information regarding the impact that gardening could have on members of the community with neurological impairments, although gardening is becoming somewhat known as an activity for those with dementia (Buck, 2016;

While, 2020). After implementing gardening programs in nursing care facilities, residents reported higher life satisfaction, more social interactions, and less lonesomeness (Temple, et al., 2015; Tse, 2010). Depression and resilience are improved in long-term care settings after gardening programs are introduced to the residents (Temple, et al., 2015). Qualitative studies agree that gardening positively impacts mental and physical health (Buck, 2016).

There is also no research about how gardening can impact end-of-life and palliative care (While, 2020). Frequently, gardens are envisioned as quiet, private areas that are a part of a home, but gardens can be a part of a public space, hospital, nursing home, or hospice facility (Buck, 2016). Gardens are connected to decreases in cancers, heart disease, musculoskeletal conditions, obesity, and increases in mental health and physical activity (Buck, 2016). Group or community gardening can help people understand health and wellbeing issues, leading to better nutrition, increased mental wellbeing, caring, and social contact (Ruck, 2020).

As the population ages, there is an increasing need for actions to reduce chronic health challenges, to improve exercise and social connectedness, and create opportunities for mental wellness. Backyard gardening can increase consumption of fresh vegetables and fruits as well as provide a means for multiple wellness outcomes. The health and wellbeing of individuals throughout all ages of a lifespan can be positively impacted by gardening (Buck, 2016). The increase in the consumption of vegetables and fruit for children who learn to garden is one significant connection, but there are many others (Buck, 2016; Ryan-Krause, 2018).

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coordination (Ryan-Krause, 2018). For children afflicted with behavioural or developmental delays, gardening presents practical, non-academic tasks in a peaceful area (Buck, 2016). Gardening creates a sense of environmental awareness in children that follows into adulthood (Ryan-Krause, 2018). A garden is an area for leisure, recreation, social communication, play, and activities for all ages (Ruck, 2020; While, 2020).

2.4 Pesticides and Organic Food

The ingestion of pesticides is an issue for some individuals. Gardeners report that they prefer to eat homegrown food because they know it is pesticide-free (Carney, et al., 2011). Researchers found that if the soil includes pesticide, the absorption of chlorinated pesticides in plant specimens can be quantifiable in the vegetation, primarily in plants and foods having a high-fat content (Hovánszki, et al., 2007) such as avocados, nuts, and seeds (The Government of Canada, 2019).

Agriculturalists have used pesticides in food production for many years. For example, in World War II, nerve gas contained organophosphate compounds, which became standard use in low doses for pesticides (Hertz-Picciotto, et al., 2018). These compounds break down quickly in the environment and were considered safe at the time, and consequently, human exposure was widespread for decades (Hertz-Bicciotto, et al., 2018). Now it is known that organophosphate compounds can cause developmental delays in children, neurological disorders, and death, and many countries, including Canada, have banned these substances (Hertz-Picciotto, et al., 2018). In the 1990s, neonicotinoids were widely used as pesticides to replace organophosphate compounds (Craddock, et al., 2019). Fruits and vegetables grown in soil treated with these pesticides contain varying degrees of these substances even if growers had not treated the plants themselves (Hovánszki, et al., 2007). Further studies are required to know the effects (Craddock,

et al., 2019). This brief discussion of pesticide use reiterates a valuable lesson – what is considered acceptable today may be proven dangerous tomorrow. Researchers have yet to study long-term exposure and side effects of pesticide use; however, growing food in a backyard garden allows people to know what chemicals they are eating.

In the late twentieth century, the benefits of organic food began to emerge (Rana & Paul, 2017). The practice of eating organic foods for health purposes has become widespread in the intervening years. Every country has its own rules for what constitutes "organic" food. The standards for organic food in Canada are outlined in a titled document *Choose Canada Organic* by Agriculture and Argi-Food Canada (2019). For the Canadian Government to label food as organic, environmentally, and animal-friendly, farming methods must have been used to grow the food. There are strict limits on pesticides, artificial fertilizers, sewage sludge, irradiation, and genetically modified foods.

Methods for cultivating organic produce include rotating crops, using "green" manures for soil nutrients, introducing select insects for pest control, and manual and mechanical methods of pest and weed control. Organic produce cannot be completely pesticide-free because of pre-existing contaminated soil, air, and water. As organic farming gains popularity, more organic foods will also be pesticide-free (Agriculture and Argi-Food Canada, 2019). If the soil did not experience an application of pesticides in the past, there might be a decrease in the number of pesticides consumed by growing one's food in an urban garden.

Based on the strict regulations in Canada, consuming organic food is arguably one of the best ways to avoid ingesting pesticides. Numerous policymakers, preservationists, and consumers think an increase in organic agricultural practices will improve environmental performance and enhance public health (Vittersø and Tangeland, 2015). The public is becoming

increasingly aware of organic food, and their perception is positive (Basha, et al., 2015). Not only does food have enjoyable sensory qualities such as taste and texture, but it also has positive non-sensory qualities (e.g., benefits to wellbeing) that are essential to some consumers of organic produce (Ditlevsen, et al., 2019). Expected health gains, concern for the environment (Denver & Christensen, 2015), the desire for locally obtained food, environmental concerns, and food safety are other reasons consumers choose to purchase organic produce versus the less expensive conventionally cultivated food (Ueasangkomsate & Santiteerakul, 2016).

There are multiple reasons why consumers purchase organic food over conventionally obtained food, despite the higher price tag. Consumers who tend to be more self-indulgent are more likely to buy organic food while believing that the price of food is the least concerning aspect of obtaining food (Prentice, et al., 2019). Animal welfare and food taste are also fundamental reasons consumers choose organic options (Ditlevsen, et al., 2019). Modern consumers are becoming increasingly concerned with lifestyle illnesses, such as heart disease, diabetes, and depression, and some turn to organic practices to combat these issues (Rana & Paul, 2017). Some consumers see organic foods as pure and safe, while conventionally grown foods are contaminated (Ditlevesen, et al., 2019). Although it has been challenging to define sustainability with food systems, some people recognize organic agricultural practices as a method to create sustainable land and diets (Azzurra, et al., 2019). Consumers concerned with the sustainability of food production are more likely to buy organic and demonstrate sustainable everyday behaviours (Azzurra, et al., 2019). It would appear that economic and health concerns are factors in consumers choosing organic food.

The food market can be confusing, with some producers trying to maximize profits by advertising to the modern consumer concerned about healthy food. Food labelling is a necessary

step that manufacturers must take to assist consumers in making informed food choices (Prada, et al., 2017). The labels on food list the ingredients, the nutritional contents, and manufacturing information, and this information creates expectations among consumers but can also be misunderstood or misconstrued (Prada, et al., 2017). Studies have shown that labelling a food product as "organic" creates expectations for consumers that may not align with reality by suggesting the food is more favourable than it is, even when evidence to the contrary exists (Prada, et al., 2017). For example, some food consumers labelled to be organic felt they did not have to exercise because they bought organic rather than conventional products (Prada, et al., 2016).

Some consumers also believe that organic food has more nutritional value, is safer to eat, tastes better, and enables improved mental performance than conventionally grown food (Sörqvist, et al., 2015). When an unrecognized brand advertises itself to be organic, consumers report positive beliefs and increased trust in that brand (Ellison, et al., 2016). When producers used organic food to make processed foods, some consumers perceived it to be tastier and healthier than conventional processed food (Prada, et al., 2017). Consumers were skeptical when presented with scientifically derived evidence that organic food is not more nutritious than conventional food. They stated that the long-term benefits were unknown, and more research was needed, suggesting that personal perceptions, beliefs, and anecdotal evidence often trumps scientific evidence (Olson, 2017).

The perception that increased health benefits result from consuming organic foods may be at odds with the scientific proof of such claims, but perhaps the benefits are in the beliefs. When asked about food consumption and health, numerous consumers will mention buying organic food (Ares, et al., 2015). Wellbeing is a concept defined as having "calmness, health,

happiness, positive emotions and satisfaction with specific aspects of life, and that food consumption can improve perceived wellbeing. The effects of foods on wellbeing were strongly related to perceived physical health, pleasure, and emotional aspects" (Apaolazza, et al., 2018, p. 52). There is a link between eating organic and perceived wellbeing, and there are strong suggestions that this link is due to the label effect (Apaolazza, et al., 2018). Consumers of organic food conferred health and wellbeing, which meant purity for their bodies and of the food consumed. This belief did not hold up when the conversation widened to healthy eating from a purely nutritional aspect (Ditlevsen, et al., 2019).

2.5 Urban Gardening Community

Another recurring theme in the literature is the link between the increase in the number of community gardens and food sharing in an area (Hunold et al., 2017; Conk & Porter, 2016; Lamalice, et al., 2018; Huang & Drescher, 2015; Carney, et al., 2011; Lovell et al., 2014; Kolodinsky, et al., 2017, McFadden, et al., 2016). Community gardens have similar benefits to home gardens as they are associated with increased vegetable and fruit consumption, decrease obesity rates, lessen food insecurity issues, and improved nutrition in areas where there is limited access to grocery stores (Conk & Porter, 2016; Lamalice, et al., 2018; Carney, et al., 2011; Kolodinsky, et al, 2017). Overall, there must be a drive and need from the community, and support from the municipal government to initiate and maintain community gardening projects (Huang & Drescher, 2015).

At the same time, the health and wellbeing of residents who participated in community gardening are observed to positively impact the social aspects of the residents' lives and assist with food security (Lovell, et al., 2014). Home gardens are associated with providing nutritionally significant amounts of fresh produce (Conk & Porter, 2016), improved nutrition,

increased vegetable and fruit consumption, activity levels, and mental health, and decreased obesity rates (Carney, et al., 2011; Conk & Porter, 2016; McMahan, et al., 2014).

Education is beneficial for individuals to garden effectively. Gardening and agriculture groups and businesses promote education and support for gardeners and offer support for those still learning the techniques (McMahan, et al., 2014). Additionally, people within a community can teach each other to garden for food and having acquaintances who garden increases the likelihood that others will learn and take up the practice (McMahan, et al., 2014). Interestingly, the higher the participants' education level, the more likely they were to have a positive belief about eating vegetables and fruits, and the more likely to believe that gardening was beneficial (McMahan, et al., 2014). Those who were knowledgeable and educated about gardening were highly likely to view gardening positively (McMahan, et al., 2014). Offering gardening information to both novice and more experienced gardeners via agricultural groups and businesses and communities working together to impart gardening knowledge to one another would be beneficial. Community health nurses can assist with this by holding information demonstrations, public presentations, providing online resources, and information brochures on gardening for health, nutrition, and general wellbeing.

In addition to adults gardening, children benefit from gardening and educational programs as well. Nutrition education, parental involvement, and the maintenance of a garden increase children's fruit and vegetable consumption (Laubert, et al., 2017; McAleese & Rankin, 2007; Bishop & Landry, 2014). Positive beliefs about vegetable and fruit consumption increase among children when schools implement curricula for gardening and nutrition (Bishop & Landry, 2014) and with the inclusion of cooking classes and demonstrations (Linnell, et al., 2014). The initiation of programs aimed at children increases the children's interaction with

nature, allows the children to be directly involved with the food supply to build a healthy relationship with food, and provides physical exercise (Kortright & Wakefield, 2011). Children can build lifelong healthy eating habits and lifestyles by gaining an education surrounding gardening and proper nutrition.

2.6 Growing Zones

One challenge to food production in Canada is the short growing season. Canada has diverse growing zones from the temperate zone on Vancouver Island (Zone 8) to colder climates on the northern prairies, such as Saskatoon (Zone 3) (Natural Resources Canada, 2017). Successful gardening requires knowledge about these variations and related approaches to the cultivation of produce in different parts of the country. For example, populations in the arctic have specific difficulties with agriculture for food self-sufficiency, such as significant temperature differences between day and night, different lengths of growing seasons, and different soil composition, so building community greenhouses could assist with alleviating these concerns (Lamalice, et al., 2018). The nutritional needs for zone 5b are the focus of this study because it benefits Peterborough, Ontario, where I live, who want to grow and consume food on their own terms.

2.7 Community Health Nursing

Community health nurses (CHNs) are the target audience for distributing this brochure. The practice is guided by the Community Health Nurses of Canada (CHNC) Professional Practice Model and Standards of Practice (2019). The standards state that CHNs must "promote, protect, and preserve the health of people, groups, communities, and populations where they work, live, and play" (Community Health Nurses of Canada, 2019, p. 12). According to the CHNC (2019), CHNs must assess the social detriments of health, support health capacity by

keeping with client participation and capabilities, advocate for healthy living, take part in knowledge generation and translation, and work at a high level of autonomy. The health of a population is influenced by life circumstances, beliefs, and the determinants of health such as environmental, physical, social, and economic variables (Community Health Nurses of Canada, 2019 p 16).

As the most significant health workforce, nurses are well situated to care for individuals living with chronic diseases. One such innovation is supporting families to use a backyard garden to grow their food, ensuring nutritional requirements are met. Gardening for nutrition is a topic that CHNs can address, allowing clients to have autonomy over their health and more control over food decisions.

2.8 Brochure as a Health Promotion Tool

An informational brochure is a health promotion tool to educate and support people – in this project, the intent is to help give families who want to garden for nutritional purposes. A resource developed in France by Haute Autorité de Santé (HAS), entitled *How to Produce an Information Brochure for Patients and Users of the Healthcare System* was utilized for the production of this brochure. It is a step-by-step guide for creating a brochure for specifically healthcare needs. Healthcare brochures aim to provide accurate, precise, succinct, and readily accessible information based on factual scientific evidence (HAS, 2008). As previously noted, the information must be accurate, reliable, easy to understand, relevant to the issue, and be able to supplement verbal health teaching and can be a beneficial asset for patients and nurses to make informed decisions on future care and health plans (HAS, 2008). The basis of brochures must be on sound scientific data and best practice guidelines (HAS, 2008).

Brochures can be a beneficial tool for healthcare providers to give easy to understand information to clients and families for use in daily lives. The HAS (2008) step-by-step guide for making a brochure lists the steps of brochure production as: (1) assess the need for a brochure; (2) define the topic, readers, and the type of document; (3) establish a diffusion strategy; (4) perform a critical review of the literature, assess currently available brochures, and ask users to identify their needs; (5) decide on brochure content; (6) apply writing and format; (7) choose a medium and design; (8) test readability, understanding, and format; (9) finish edits to brochure; (10) distribute brochure; and (11) assess the impact on the brochure (HAS, 2008).

2.9 Summary

There are few evidence-informed resources for CHNs on backyard gardening and little is known about the health benefits of gardening for specific populations such as those with cognitive impairments, palliative care, and end-of-life care. For this project, aim was to provide a resource for CHNs to support gardening-naïve individuals with establishing a garden for nutritional purposes. This information could serve the public to improve the health and wellbeing of many members of the population. There is little research into backyard gardens to eat organic homegrown food.

Furthermore, the current knowledge surrounding how families' nutrition relates to creating and maintaining a garden designed to cultivate most of their food is both general and lacking in specific areas. There is no research explicitly addressing household food self-sufficiency.

With proper education regarding nutrition and gardening practices, home gardens can provide many health benefits. The health and wellbeing of residents in communities who participated in community gardening was impacted by increasing the social aspects of the

residents' lives, assisting with food security and assistance with food poverty (Lovell, et al., 2014). Home gardens improve nutrition, vegetable and fruit consumption, activity levels and mental health, and decrease obesity rates (Carney, et al., 2011; Conk & Porter, 2016; McMahan, et al., 2014). Urban gardens can provide nutritionally significant amounts of fresh produce (Conk & Poter, 2016). Gardening and agriculture groups and businesses promote education and support for gardeners (McMahan, et al., 2014). Some gardeners gave away a considerable portion of the home-grown food to other people to eat, thus increasing the benefits of gardening to others (Conk & Porter, 2016). This is a benefit for other members of the population who do not garden for nutrition, leading to the further distribution of positive outcomes of gardening.

Strengthened familial relationships are a result of home gardening because the families often work together toward a common goal (Carney, et al., 2011). The higher the participants' education level, the more likely they were to have a positive belief about eating fruits and vegetables, and the more likely they were to believe that gardening was beneficial (McMahan, et al., 2014). Those who had difficulty paying bills and worried more were less likely to garden or buy produce, opting for cheaper, less nutritional food (McMahan, et al., 2014). Those who had knowledge and education about gardening were highly likely to view gardening positively (McMahan, et al., 2014).

The onset of the COVID-19 pandemic presented sudden and drastic changes to the way of life in Peterborough, Ontario, and worldwide. Food shortages in grocery stores were sudden and surprising. Food insecurity amongst Canadians grew 39% to affect one in seven people within the first two months of the pandemic (Community Food Centres Canada, 2020). The reasons given for the increase in food insecurity during the pandemic included layoffs and a hard-hit economy (Community Food Centres Canada, 2020). Garden stores were sold out of

plants and seeds. I discovered that gardening books from the local library were waitlisted, and seeds were difficult to obtain. Grocery stores were viewed as a dangerous source of disease transmission, and some consumers wiped down all food with disinfectants upon arriving home (Khan, 2021). I found that long lineups to enter grocery stores and one person per household limits made for stressful, anxious experiences. Food hoarding by some individuals created a more significant deficit of food choices for other consumers (Wang & Hao, 2020). A tool for backyard gardening such as this brochure could prove helpful for many community members who had never considered gardening for food in the past.

Home gardens can be a way to increase the servings of vegetables and fruits in a family's diet. Gardening for nutritional purposes is one method of reducing pesticides in diets and ensuring that all food consumed is organic. A pesticide-free garden decreases the risk of allergic reactions to the pesticides used, lowers obesity rates, and increases overall health. Urban community gardening projects have similar benefits to personal gardens. The development of a brochure for gardening information can supplement gardening information in an easy-to-understand, concise and factual resource based on scientific literature**.** This brochure was created utilizing the CIW conceptual framework as a guide to enhanced wellbeing. This brochure also used Lewin's Three-Step Model for Change to examine how people accept and implement change. This brochure will be given to the PPHU and the PFHT, put online as a downloadable resource, and given to the local colleges and universities to enhance their current nursing programs. The HAS model was employed to create the brochure using specific instructions.

CHAPTER 3. METHODS

The purpose of this project was to create a brochure to give families information about how to establish and maintain a backyard garden to meet their nutritional needs and aid with food self-sufficiency. Using the HAS guide, I created a multimedia-friendly brochure to inform families based on current information (e.g., books, government websites, digital documents, etc.). The HAS guide provides specific instructions about how to produce a succinct, easy-to-understand brochure. This step-by-step guide for making a brochure lists the steps of brochure production as: (1) assess the need for a brochure; (2) define the topic, readers, and the type of document; (3) establish a diffusion strategy; (4) perform a critical review of the literature, assess currently available brochures, and ask users to identify their needs; (5) decide on brochure content; (6) apply writing and format; (7) choose a medium and design; (8) test readability, understanding, and format; (9) finish edits to brochure; (10) distribute brochure; and (11) assess the impact on the brochure (HAS, 2008). I completed the brochure to step 9, and I will advance to step 10 in the next phase of this project. The production of this brochure employed the CIW conceptual framework and Lewin's Three Step Model for Change.

3.1 Intended Audience

The intended audience for this brochure is families who want to establish and maintain a backyard garden for increased household food self-sufficiency. Nurses and other healthcare workers can distribute this information to individuals who express interest in developing gardening skills.

3.2 Brochure Development

There is little research and no nursing literature that I am aware of on the best way for families to incorporate vegetable gardening into their daily lives. There are, however, many popular gardening books, but books can be overwhelming for novice gardeners due to the overload of information on the topic. Those interested in vegetable gardening can have a difficult journey trying to navigate what can be grown and in what seasons, and finding information on pest control to maximize success and the positive benefits. Gardening is a learning process, and gardeners need introductory knowledge with links to resources as they mature in their operation.

To increase available information about backyard gardens, I have created a brochure that nurses and other health care professionals can share with clients (see Appendix A). The design of the brochure was for use as (1) a hardcopy handout and (2) available for websites/webpages as a downloadable resource. Information in the brochure was compiled through a review of the literature. The trustworthiness of the information found was examined by observing the information and determining if I hold any bias. While I do have personal gardening experience, I reviewed and presented the data without any predisposition. The information found did not contrast with my own personal experience, which aligned with available information. The interpretation of the data was straightforward, as the facts are presented in an informative way, leaving little room for ambiguity.

Electronic searches of CINAHL Plus, Web of Science, The Peterborough Public Library, Google Scholar, and Google were performed using the following search terms alone and in combination: "nutrition," "public health," "organic food," "gardening," "backyard garden," "urban agriculture," and "pollination." The searches yielded popular books, websites, and other digital sources. After an extensive search, no peer-reviewed journal articles could be located that

were of use for backyard gardening for nutrition, specifically investigating the “how-to” question. There are journal articles relating to nursing and gardening for health benefits. Still, none could be found for the specific instructions for how to incorporate gardening into the lives of a novice, would-be gardener. Books and websites were included in the review if published in the English language between 2013 and 2020, the primary focus was backyard gardening, and information contained "how-to" instructions for gardening. Backyard gardening in zone 5b was of particular interest to share the resource in my local area. There were 141 sources identified. The titles and abstracts of the sources were screened to ensure they met the inclusion criteria, with 12 remaining (see Prisma diagram in Appendix B). Major themes from the sources were reviewed and summarized in a data extraction table [author(s), publication year, purpose, type of literature, major themes] (see Appendix C). The grey literature was evaluated using the Accuracy, Authority, Coverage, Objectivity, Date, Significance (AACODS) checklist (Tyndall, 2010). The AACODS checklist requires information as described in Appendix D. Grey material such as websites and books were accepted or rejected using this criterion. Key messages from the grey literature were used to create the brochure. These messages were identified by asking questions such as: "Is this information needed for families?" "Is this information beneficial?" and "What will this brochure add to the public?" (HAS, 2008).

This brochure is for nurses and other community healthcare providers to distribute to their clients of the PPHU and the PFHT. The Ontario Ministry of Health funds both organizations. In addition, this information is available to the nursing programs at the local colleges and universities to enhance the existing programs. A brochure model was chosen rather than a podcast or video because a brochure is printable, accessible without technology, and, for some people, easy to understand.

3.3 Brochure Layout

The practical layout of the brochure is essential for readability, comprehension, and maintaining the reader's attention (HAS, 2008). Large amounts of text are unappealing, whereas pictures can break up the monotony of too many words (HAS, 2008). The presentation of the text and images should be balanced, and sentences must be clear and concise, consisting of 15-20 words (HAS, 2008). The brochure should be written in a personal tone, positive and reassuring, while not condescending (HAS, 2008). The brochure should contain clear headings with a simple, easily understood vocabulary with appropriate font size (HAS, 2008). The use of colour can attract the reader, but too much colour can distract (HAS, 2008). The brochure for this project was directed towards people looking for how to establish and maintain a backyard garden for nutritional purposes.

3.4 Brochure Topics

The brochure can guide growing organic, pesticide-free vegetables and fruits in Peterborough, Ontario. The discussed topics in the brochure are the importance of healthy eating and nutrition, gardening for nutrition, the tools required for practical gardening, common garden pests, garden resources, how and when to plant seeds, how and when to plant transplants, community resources, and the added health benefits for gardening. The brochure is six pages in length and planned to keep readers engaged with pictures and concise instructions.

3.5 Summary

This brochure is limited to being written in the English language because of lack of resources for translation. This brochure is limited to a review of the literature, and no user input was obtained in developing the topic areas due to the COVID-19 pandemic. The information is limited to Zone 5b or warmer, applying to the investigator's local area.

CHAPTER 4: FINDINGS

Gardening is an activity that involves some work and effort to yield positive results. I present the results of the literature review, which informed the creation of the brochure. The objectives of this study were to (1) identify the foods that can be grown in Zone 5b in Canada (Peterborough, Ontario) that satisfy nutritional requirements for a healthy diet; (2) determine the required home infrastructure needed to maximize household food self-sufficiency; (3) identify community supports to meet nutritional needs when commercially grown food is not acceptable; and (4) develop nursing knowledge on supporting families with home food production. When applying Lewin's Three-Step Model for change, this chapter describes how to help an individual who has experienced the unfreezing stage, and the next stage is changing/moving. This information is the teaching and coaching portion, enabling the brochure user to learn new skills for food production. This chapter describes what to plant, the infrastructure needed for a home garden, and community supports for families with food allergies seeking alternatives to the industrial food system. Without this information, people would have an increasingly difficult task of learning this information, and the refreezing stage may be more challenging, if it happens at all. The individuals may not find this information otherwise, and continue to search for ways to eat pesticide-free food, experiencing the adverse health outcomes that may occur.

4.1 Objective 1: Growing Food in Zone 5b

4.1.1 Growing Zones

Growing food can be both an art and a science. Understanding some basic information can help gardeners to make the best choices to be successful. What to plant when is essential to understand. The survival of certain plants is dependent on the growing zone where a person lives. The United States Department of Agriculture (USDA) designed plant hardiness zones by

accumulating weather information over several years and divided North America, Europe, and China into 11 zones, with every zone characterized by its average yearly minimum temperature (Brock, 2019). Each of the 11 zones has an annual minimum temperature of 10 degrees Fahrenheit warmer or colder in an average winter season than the adjoining zones (Brock, 2019). Zones 2-10 on some North American maps are divided into a and b regions, with the lowest average yearly temperature being five degrees Fahrenheit warmer or cooler than the adjacent zones (Brock, 2019). For example, zone 5b is five degrees Fahrenheit cooler than zone 5a (Brock, 2019). These hardiness zones are what gardeners use to determine whether a particular plant will survive in a specific area. Not all plants are equal when it comes to the ability to survive extremely high or extremely low temperatures (Murphy, 2018).

4.1.2 Time of The Year

It is also essential to understand what "climate" is and how it affects gardening. Climate is influenced by where an area is located globally, including its elevation, topography, proximity to bodies of water, wind direction, and latitude (Murphy, 2018). The rainfall, humidity, average high and low temperatures, and the growing season's duration result from an area's climate (Murphy, 2018). Generally, the length of a growing season is from the last frost in the springtime and the first frost of the fall season (Murphy, 2018). In Zone 5, the average last frost in the springtime is between March 30 and April 30, and the average first frost in the autumn is between September 30 and October 30 (Murphy, 2018). This information can be used to decide which plants will grow the best, the timeline for planting, whether to initiate seed growth indoors or if one can plant seeds directly into the garden (Murphy, 2018). For example, tomato seeds are initiated indoors because they take approximately 120 days to go from seed to crops, and Zone 5b has a shorter growing season (Murphy, 2018). Gardeners may also consider planting cool-

season vegetables weeks before the first fall frost (Murphy, 2018). Plants that require full sun need 6-8 hours a day of either continuous or divided sunlight, whereas partial sun and partial shade plants require between 3-6 hours of sunlight per day in the morning before the sun becomes too powerful (Murphy, 2018). Shade or full shade plants require less than 3 hours per day of direct sunlight in the morning (Murphy, 2018). Having a general understanding of the basics of climate will assist in decision-making for the garden.

4.1.3 Plant Choice

Gardeners need to determine which annual and perennial plants to grow. Some plants like carrots, potatoes, cabbage, and beetroot require crop rotation to prevent soil-borne pests and plant diseases from ruining crops (Lavelle et al., 2015). Planting the same crops every year will deplete the soil and decrease yields (Lavelle et al., 2015; The Ontario Trillium Foundation, 2009). The gardener should also group certain crops to discourage the common pests that they attract. Compost and manure are possible choices for replenishing the nutrients and re-establishing the soil's pH for a new season (Lavelle et al., 2015). For example, gardeners can rotate strawberries with flowers or herbs to prevent pest issues (Lavelle et al., 2015). Perennial crops such as asparagus, blackberries, raspberries, and rhubarb grow in a designated area and grow the best without rotation (Lavelle et al., 2015). Some crops are more problematic than others. For example, while it is possible to grow in climate 5b, peaches are disease-prone and involve an abundance of time and care that it may be best to plant alternative, more agreeable crops (Lavelle et al., 2015).

4.1.4 What to Grow?

One tip for starting and maintaining a food garden is to cultivate what you love. It will be easier to put in the time and effort into the garden if what is grown is enjoyed. To get started on

figuring out what will be appreciated, the gardener can begin by creating a list of fruits and vegetables already enjoyed regularly by the gardener and their family and what foods hold an interest in the household (Lavelle et al., 2015). By choosing items that individuals find desirable, the gardener can choose vegetables based on that flavour profile (Brock, 2019). Decide if the garden area is the right size to hold the desired crops and commence with the more accessible produce to gain the knowledge, experience, self-confidence, and aptitude before expanding out with different plants (Lavelle et al., 2015). Examples of easier crops include scallions, radishes, carrots, and lettuce (Lavelle et al., 2015). Fruit is more challenging to grow, and apples, pears, and blackcurrants can take years to produce crops, but once they start producing, the fruit will be abundant with less maintenance than vegetables (Lavelle et al., 2015).

Companion planting is a gardening method in which gardeners purposely plant-specific vegetation together, as the smell of the plants' volatile oils discourages certain pests (Lavelle et al., 2015). Also, planting fast-growing crops between slower-growing main crops will augment efficiency and a high yield, reducing competition for moisture and nutrients while deterring weeds (Lavelle et al., 2015). Plant faster-growing vegetables at regular intervals to ensure constant food supplies (Lavelle et al., 2015).

4.1.5 Seeds and Planting (Propagation)

Plants require soil, air, water, a suitable temperature, a place to grow long roots that can support top growth (Lavelle et al., 2015). Seeds typically germinate when the soil temperature rises above 7 degrees Celsius (Lavelle et al., 2015). Using the row planting method, sow the seeds in rows, planting 1-2 centimetres in-depth and marking each row with a sign indicating what has been planted (Lavelle et al., 2015). Peas and beans require wider rows (Lavelle et al., 2015). Be aware that birds and animals will eat seeds so that gardeners can use barriers for

protection, such as low tunnel chicken wire and stakes with netting (Lavelle et al., 2015). Seedlings require gentle handling by the leaves, never holding them by the stems and should be planted 5 centimetres apart (Lavelle et al., 2015). Transplanted seedlings require watering with room temperature water as cold water can shock the plants (Lavelle et al., 2015).

Saving seeds for the next growing season is an option for open-pollinated varieties of plants but not hybrids (Niemann, 2017). Seeds from self-pollinating plants are easier to save, and plants will look like their parents (Niemann, 2017). In contrast, pollination by wind or insects can be cross-pollinated, and the following plants may be a surprise because their genetic make-up will be a combination of the two parent plants (Niemann, 2017). Beans, eggplant, lettuce, peas, peppers, and tomatoes are all examples of self-pollinating plants. In contrast, broccoli, cabbage, Brussels sprouts, cucumbers, melons, okra, turnip, onion, carrots, radishes, beets, and summer and winter squashes are all examples of wind and insect-pollinated plants (Niemann, 2017).

The planting supplies and seeds used should be of good quality and be pest and disease-free (Ministry of Agriculture, Food and Rural Affairs, 2021). While more experienced gardeners may be able to start the seeds indoors to transplant in the garden later, greenhouses are excellent for germinating seeds because the ventilation, water, and light are controlled (Ministry of Agriculture, Food and Rural Affairs, 2021). Buying seedlings is more cost-effective, saves time, and should be free of herbicides, weeds, insects, and diseases (Ministry of Agriculture, Food and Rural Affairs, 2021).

4.1.6 Pollination

Attracting pollinators to the garden is an integral part of the natural processes of cultivation. The plant's basic anatomy demonstrates that a plant must be pollinated (i.e., pollen

from the male flower's stamen must be transferred to the female flower's stigma) to produce fruits (Bradbury, 2010). Some plants, such as tomatoes and peas, are self-pollinators, and the pollinating insects or wind can pollinate the plant independent of other plants (Bradbury, 2010). However, other plants such as squash and cucumbers produce separate male and female flowers, requiring other plants to produce fruit (Bradbury, 2010). In the latter, pollinating insects will collect nectar and pollen from a flower and then visit another flower of the same species, rubbing some of the pollen off onto the new flower r (Bradbury, 2010). If the pollen from the stamen is deposited into the stigma, pollination has occurred, and fruit will develop on that flower (Bradbury, 2010). Other crops, such as corn, are pollinated by the wind (Bradbury, 2010). Tart cherries, apricot, or peach are all examples of a single tree producing crops. In contrast, apple trees, pear trees, plum trees, and sweet cherry trees require pollination from another tree (Ministry of Agriculture, Food and Rural Affairs, 2021). This information can assist when helping people know what is necessary to produce crops from certain plants.

4.1.7 What to Plant and When

Tables 4.1 and 4.2 contain lists of some vegetables and fruits commonly grown in zone 5 using seed planting and transplantation.

Table 4.1. Planting Seeds

Type of Seed	Distance Between Plants	Planting Depth	Planting Dates
Bush Beans	5-8 cm	4—5 cm	May 5—June 15
Beets	3-5 cm	1.5 cm	April 20—June 1
Broccoli	45-60 cm	0.5—1.5 cm	May 5—July 15
Carrots	3-5 cm	1.5 cm	April 15—June 1
Cucumber	30-60 cm	1.5—2.5 cm	June 1– June 10
Kale	60 cm	0.5 cm	April 1—June 1
Lettuce (Head)	30cm	0.5—1 cm	April 1—10; and June 25—July 5
Potato	25—30 cm	10 cm	April 5—June 1
Radish	2.5 cm	1.2 cm	April 1—May 1; and Aug 1—Sept 1
Squash	60—120 cm	2—3 cm	May 25—June 10
Thyme	15 cm	0.5-1 cm	May 10 to May 30

Table 4.2. Transplanting

Type of Seedling	Distance Between Plants	Transplantation Dates
Broccoli	45-60 cm	April 25—May 5 for early or June 1—July 15 for late crops
Brussels Sprouts	60 cm	April 5—April 25
Cucumber	30-60 cm	June 10—June 20
Lettuce (Head)	30 cm	April 1—April 20
Peppers	60 cm	June 1—20
Rhubarb	90 cm	April 14—May 1
Tomatoes	90 cm	May 15—June 16

4.1.8 Maximizing Yields and Harvesting Crops

After expending so much time and effort in a garden, it would be beneficial to maximize yields and properly harvest the crops. First, plan to grow what will be harvested and consumed, avoiding over planting (The Mel Bartholomew Foundation, 2017). To ensure healthy and edible produce, keep any diseased plants away from healthy plants to stave off infections (Lavelle et al., 2015). Pick the crops and store the surplus appropriately, remembering that root crops can remain in the soil until the coldest weather arrives (Lavelle et al., 2015). Harvesting underdeveloped produce or keeping produce that is not in optimal condition can lead to yield loss (Lavelle et al., 2015). Some vegetables, including parsnips, beets, Brussels sprouts, cabbage, carrots, collard greens, kale, leeks, rutabagas, spinach, Swiss chard, and turnips, taste better after a frost (Lavelle et al., 2015). This is because the starch in the plant turns to sugar, which operates as a kind of antifreeze, causing a more pleasing taste (The Mel Bartholomew Foundation, 2017). If tomatoes are still producing fruit when frost threatens, trim the branches off, bring them inside the house and put them in water to grow roots and last additional time (Niemann, 2017). Produce that has ripened while still attached to the plant in the garden will taste better and have extra nutrients than produce picked immaturely and ripened off the plant (Niemann, 2017). When the gardener leaves crops on the plant for a prolonged time, the crops become increasingly susceptible to pests or disease (Ontario Ministry of Agriculture, Food and Rural Affairs, 2020). Prevent forceful handling of the crops to avoid diseases (Ontario Ministry of Agriculture, Food and Rural Affairs, 2020). When produce experiences bruising off the plant, the nutritional benefits are lost more quickly, and the sooner the food is eaten, the better (Niemann, 2017). Most fruits and vegetables are non-climacteric, meaning that it will stop growing as soon as it is picked (The Mel Bartholomew Foundation, 2017). Climacteric fruits can ripen off the plant by

producing high amounts of ethylene gas to encourage ripening (The Mel Bartholomew Foundation, 2017). It is essential to know, on average, how long it takes for crops to ripen. Radishes will ripen in 25 days, scallions will ripen in 28 days, cucumbers will ripen in 53 days, peas and turnips will ripen in 60 days, and zucchini will ripen in 70 days (The Mel Bartholomew Foundation, 2017). It will take two years for planted asparagus to become established and be edible (The Mel Bartholomew Foundation, 2017). With proper ripening techniques and storage, the yields grown will be nutritious and feed a family without much waste.

4.2 Objective 2: Infrastructure

4.2.1 Soil, Compost, And Fertilizer

When people think about planting and growing vegetation, they often use the word "dirt" to describe the medium they are planting in. The term "dirt" can have negative connotations, with synonyms such as "grime," "filth," "excrement," and "muck." The truth is that soil is where life begins and ends, as all life, once concluded, decomposes into its constituent materials (Råman et al., 2017). The rotation of nutrients like water, carbon, nitrogen, phosphorous are significant and go through natural rhythms in their natural surroundings with our effects on them notwithstanding (Råman et al., 2017). Soil is a multifaceted living community, and everything is linked by the food chain (The Mel Bartholomew Foundation, 2017). Despite negative connotations of soil, it is vital to life on this planet. It is more accurate to refer to soil as "earth," as it is the most fundamental component to life, whether growing food or decomposing wastes to be rebuilt and flourish once again.

4.2.2 Soil Types

There are different types of soil for growing plant life. There are several different soil components, such as rocks, sand, clay minerals, decaying and decomposing organic matter,

bacteria, fungi, worms, insects, air, and water (Lavelle et al., 2015). Soil is broken up into categories of sandy soils, silt soils, and clay soils (Råman et al., 2017; Murphy, 2018; Lavelle et al., 2015; The Ontario Trillium Foundation, 2009.; Blackmore, 2017; Ministry of Agriculture, Food and Rural Affairs, 2021). Distinguishing soil type can be relatively straightforward.

Sandy soils contain bulky fragments, are light, porous and are straightforward to work with (Råman et al., 2017). The larger soil pieces permit distance between the particles, and water drains rapidly, frequently taking essential nutrients with it (The Ontario Trillium Foundation. 2009). Sandy soils are well aerated, but the inability to hold moisture makes this soil not ideal for planting (Brock, 2019). When you squeeze sandy soil into a ball, it falls apart and fails to hold together when you release it, and sandy soil feels gritty when you run it between your fingers (Brock, 2019).

Silt soils are composed of particles of both sand and clay (Råman et al., 2017; The Ontario Trillium Foundation, 2009; Lavelle et al., 2015). Silt contains particles small enough to cause drainage problems, does not preserve vital nutrients, and is challenging to work with once it is wet (The Ontario Trillium Foundation, 2009; Lavelle et al., 2015).

Clay soils contain tiny particles that easily cluster together, are rich in nutrients, and hold water well (Råman et al., 2017). Due to the lack of space between the particles, clay soil does not have enough air for plants to prosper (Råman et al., 2017; The Ontario Trillium Foundation, 2009; Brock, 2019; Ministry of Agriculture, Food and Rural Affairs, 2021). Therefore, clay soils have reduced drainage, and when it is waterlogged soil, air cannot penetrate, causing even less air availability (The Ontario Trillium Foundation, 2009). When you squeeze clay soil in your hand, it oozes out of your hand as you compress it and stays in a slimy ball when you release

your grip (Brock, 2019). Clay soil feels slippery when you rub it between your fingers (Brock, 2019).

The best soil for establishing a garden is loam (The Ontario Trillium Foundation, 2009; Lavelle et al., 2015; Brock, 2019) as it has the best combination of sand, silt, and clay (The Ontario Trillium Foundation, 2009; Lavelle et al., 2015; Brock, 2019). Loam holds a favourable amount of water while the surplus water drains away, letting air into the soil to benefit the roots the other living organisms located within the soil (The Ontario Trillium Foundation, 2009; Brock, 2019). Light loams are 12-18% clay and should be treated like sandy soil, while heavy loams are 24-30% clay and should be treated like clay soil (Lavelle et al., 2015). The ideal loam is medium, with a clay percentage of 19-23%, because it has the advantages of both sandy soils and clay soils without the disadvantages of either (Lavelle et al., 2015). When you squeeze loam soil in your hand, it stays together after releasing it but falls apart easily when agitated (Brock, 2019; The Ontario Trillium Foundation, 2009). Knowing what kind of soil you want and the soil you have can assist in the development of the best soil for growing food.

Now that we know what soil is best for establishing and maintaining a garden, we consider achieving this soil for gardening. Gardeners can make modifications to the soil to add nutrition and transform it into loam. There are four essential additives to improve soil noted in Table 4.3. Adding organic matter to sandy soils regularly to make it ideal for planting can be beneficial because sandy soils warm up faster in the spring, allowing for a comprehensive range of plants and making planting and transplanting simpler (Lavelle et al., 2015; Brock, 2019). The gardener can enhance the existing soil in a garden with some adjustments to create an ideal environment for plant life to thrive.

If the soil will be purchased, it is best to buy an organic mix of topsoil and compost with ratios of either 60:40 or 50:50 (Murphy, 2018). Compost makes garden soil better by loosening and aerating clay, improving water and nutrient holding capacity, and providing once-living material that attracts microorganisms such as beneficial fungi, worms, and other soil-borne organisms to the health of the vegetables (Brock, 2019). Adding a 2-5-centimetre layer of compost on the area designated for vegetable planting and working it into a depth of 15 centimetres with a shovel, fork, or rototiller will enhance garden soil (Brock, 2019). Gardeners should only apply manure after fully composted for a year or two, so the salts leach out because excess salt is harmful (Brock, 2019). Chemical fertilizers are unnecessary, and it is best to rely on kelp meal, fish fertilizers, manures, organic mulches, and compost for plant and soil nutrition (Blackmore, 2017). After any modifications have been added, turning the soil allows everything to break down faster and nutrients to be available for the plant roots.

Table 4.3. Soil Additives

Additive	**Soil Type**	**Mechanism**	**Origin and Method**
Lime	Clay	Raises pH causing it to clump together	Composed of calcium and magnesium. add any time of the year, overcompensating is possible
Composted bark	Clay	Breaks down slowly; creates drainage	From spruce or pine trees - pH neutral bark is best; less is used without replacing it yearly
Compost	Clay, sandy, silt	Upgrades the retention of water and nutrients in sandy soils and promote drainage and aeration in clay and silt soils	Decomposed plant matter; add any time of the year
Humus	Clay, sandy, silt	Form of moderately decomposed plant matter that gives topsoil a dark colour and has a high nutrient density	Use your leaves to make leaf mould by breaking them up with the lawnmower and scatter to create mull humus. Farmyard manure; sawdust

(Råman et al., 2017; Blackmore, 2017; Brock, 2019; Lavelle et al., 2015).

Topsoil helps to give vegetation water, air, and nutrients, while subsoil (inert soil layer that lies underneath the thin coat of living topsoil) has less organic matter than topsoil (Lavelle et al., 2015). If soil is too compacted, roots cannot grow (Lavelle et al., 2015). Healthy soil is alive, packed with life such as bacteria, fungi, yeast, earthworms, and insects, so air, water and nutrients are required in the soil for them to live (The Ontario Trillium Foundation, 2009). All these life forms work to break down organic matter that yield nutrients used for root growth and plant development while amalgamating the soil to enhance airflow, consistency, and composition (The Ontario Trillium Foundation, 2009). Obtaining and maintaining the optimal soil for the food garden is crucial for gardening success and meaningful yields.

4.2.3 Compost

When discussing soil for gardening, a recurring theme is compost, a significant factor for vigorous plants and hearty growth (Blackmore, 2017). The gardener makes compost by heaping organic food waste and plant material coupled with aerated decomposition (Blackmore, 2017). This process generates microorganism nematodes and protozoa, which multiply in the soil as part of a multifaceted food web involving worms, beetles, a multitude of insects, bacteria, and fungi, which break down cellulose fibres to convert into sugars that can be taken up by the plant roots (Blackmore, 2017). You can compost kitchen waste that includes bones, garden waste, grass clippings, turf, wood ash, charcoal residue, newspapers, paper, cardboard, egg cartons, serviettes, and corrugated cardboard. You cannot compost cigarette butts, tobacco products, vacuum cleaner bags, inorganic materials such as plastic, medicines, plant waste or leaves from unhealthy plants, cat litter or similar, lime, salt, or fat (Råman et al., 2017).

4.2.4 Mulch

Mulch is a cover of organic material distributed on the soil's exterior to smother the production of weeds, maintain moisture in the summer, and protect the soil from packing and leaching during the winter (Blackmore, 2017). Mulches improve gardens by absorbing water, maintaining moisture levels, and insulating the plant (Lavelle et al., 2015). Seaweed, leaves, grass clippings and straw are all organic mulch examples that will supply bulk and provide nutrients with decomposition (Blackmore, 2017). Not only does mulch add benefits to the garden, but it is aesthetically pleasing.

4.2.5 Soil Nutrients

Using the correct soil for gardening is important, but so is maintaining the soil's critical components. Most fertile soil contains both macro-and micronutrients, and plants require both to flourish (The Ontario Trillium Foundation, 2009; Blackmore, 2017). The macronutrients include nitrogen (N), phosphorous (P), potassium (K), calcium (Ca), magnesium (Mg) and sulphur (S) (The Ontario Trillium Foundation 2009; Blackmore, 2017; Niemann, 2017). Plants need more than N, P, and K to grow, but that is what commercial fertilizers focus on as the nutrients most consumed by plants (Niemann, 2017; The Ontario Trillium Foundation, 2009). Calcium insufficiency in the soil leads to blossom end rot, while too much nitrogen causes too many leaves to grow without producing yield (Brock, 2019). If the soil has a calcium deficiency, crushed antacid tablets, soaked in water, and sprayed onto soil can prevent blossom end rot (Blackmore, 2017). Epsom salts can be dissolved in water and added to the soil for a magnesium deficiency. Banana skins can be added to the soil to aid with a potassium and phosphorus deficiency (Blackmore, 2017).

Additionally, micronutrients are required, such as iron (Fe), manganese (Mn), copper (Cu) and zinc (Zn). These substances are essential for plant life, and the proper level is necessary for a healthy and productive garden (The Ontario Trillium Foundation, 2009; Blackmore, 2017). Compost allows for a reasonable amount of these micronutrients, and most soils have enough (The Ontario Trillium Foundation, 2009). Soil testing for nutrients before planting can provide information for optimal growth and yields (Lavelle et al., 2015). Amendments can be added to optimize soil and plant production if the status of nutrients and micronutrients in the soil is known.

4.2.6 Soil pH

The pH of the soil is also of utmost importance. A low, acidic pH of 6.5 or less will not allow some vegetables like cauliflower or cabbage to grow (Lavelle et al., 2015). Often a large amount of lime is required to raise the pH, while un-limed peat is ideal for lowering soil pH (Råman et al., 2017). Plant life cannot absorb nutrients if the pH is out of range for that particular vegetation, with a pH of between 6-7 being optimal (Brock, 2019; Blackmore, 2017). Some plants require different pH levels; for example, potatoes prefer a pH between 5-6 (Brock, 2019). The gardener can test the soil to obtain the pH levels using an at-home kit or a soil laboratory (Blackmore, 2017; Brock, 2019). Changes in pH and nutrients are gradual, so if there have been past soil imbalances, test the soil every year (Brock, 2019). If the pH is below 6, add ground limestone to the soil, and if pH is above 7.5, add soil sulphur (Brock, 2019). It is important to remember that we are feeding the soil, and not just the plants (Brock, 2019). The macronutrients, micronutrients, and pH are important considerations for gardeners establishing or maintaining a garden.

4.2.7 Tools Required

Working in a garden will require more than just hands, planning, and hard work. Specific tools are an asset when toiling in the garden. There are many kinds of tools to choose from, designed for a variety of jobs. It is good to spend time deciding which tools will meet specific needs and be aware that the tool requirements may change over time (Blackmore, 2017). The gardener should be aware that the more tools accumulated for the garden, the more space required to store everything properly (Blackmore, 2017).

4.2.8 Digging and Moving Soil

The gardener can use a spading fork to turn the soil by forcing it apart to allow air and moisture into it and prepare the ground for cultivation (Blackmore, 2017; Brock, 2019). Spades come in an assortment of shapes and sizes, all of which do the same job of cutting through soil (Blackmore, 2017; Brock, 2019). Shovels also come in various shapes and sizes and cannot be substituted for spades (Blackmore, 2017; Brock, 2019). While shorter spades are preferable to longer shovels when digging in limited space, shovels allow for the tossing and spreading of soil, compost, and whatever else that the gardener is required to spread over larger areas (Blackmore, 2017). Whether to use a spade or a shovel should be determined by the size of the garden (Blackmore, 2017).

Hoes are used for hilling up rows, cutting and removing weeds, and creating small spaces for the seeds to be planted in the soil (Blackmore, 2017; Brock, 2019). The gardener uses short-handled fork hoes for loosening soil, seeding, and cultivating among the plants (Blackmore, 2017). Trowels can also be used to dig holes close to the plants without causing injury to the plants (Blackmore, 2017). Hand trowels are the best tools for digging in containers, window

boxes, and smaller gardens (Brock, 2019). The hand trowel's wider blades are designed for loosening soil, while narrow blades are better for digging out weeds (Brock, 2019).

Gardening rakes are designed to break up soil clods and smooth seedbeds (Brock, 2019). A mattock is a consolidated tool with both a claw and a small flat-edged hoe, so if space is an issue, this tool can serve multiple purposes (Blackmore, 2017). A three-pronged hand cultivator is used for disassembling soil clods, levelling seedbeds, and amalgamating fertilizer (Brock, 2019).

4.2.9 Comfort and Injury Prevention

Rubber kneeling mats are helpful for comfort and can prevent sore knees and injuries. (Blackmore, 2017). Another comfort measure is a pair of well-fitting gardening gloves, including rubberized palms and breathable backs, as the floppy cotton gloves do not protect the hands from injuries (Blackmore, 2017). The gardener should wear a sun hat, long sleeves and sunblock to prevent sun damage, and gardening shoes or boots will keep feet safe.

4.2.10 Design

Plants need certain environmental elements, such as sunlight, water, space, and soil, to develop and thrive. Therefore, it is practical to plan a garden maximizing these essential elements carefully. To effectively plan a garden, there are some steps to follow. Gardeners can begin by drawing a plan of the yard to scale, including the house, property limits, shrubbery, wires and gas meters, sheds, and anything else that is on the property (Lavelle et al., 2015). Gardeners need to consider how they want the garden to look and what they would like to grow. The gardener can choose fruits and vegetables, fruit trees, a water feature, and whatever else is of interest (Lavelle et al., 2015). Keeping in mind the desired yields will help plan how the garden

should be established and maintained (Brock, 2019). If a gardener does not have much time to spend on the garden, low maintenance vegetation would be a must (Lavelle et al., 2015).

4.2.11 Sunlight

The most important variables in planning a garden site are the amount of sunlight in a day and the quality of the soil (Brock, 2019). The garden should receive at least six hours of sunlight per day (Ministry of Agriculture, Food and Rural Affairs, 2021), so the gardener needs to observe the proposed garden area for at least a couple of days to see how much sunlight it gets (The Ontario Trillium Foundation, 2009). There must not be extensive tree coverage as the branches block sunlight, and trees' roots steal nutrients away from plants (Blackmore, 2017; Ministry of Agriculture, Food and Rural Affairs, 2021). However, thick shrubbery and small trees are not usually problematic and could protect the plants from wind (Blackmore, 2017).

4.2.12 Avoiding Pests

Portions of a garden with the same vegetation will invite abundant pests, so inter-planting is a solution (Lavelle et al., 2015). Gardeners should strategize for a four-year crop rotation and split plants into five groups: legumes (plants that produce a pod with seeds inside, such as peas and beans), brassicas (cole crops such as broccoli, cabbage, and cauliflower), root crops (crops that grow underground such as potatoes, carrots, and beets), permanent crops (crops that last for many seasons, such as fruit trees and asparagus), and the final group consists of onion, lettuce, sweetcorn, and garlic (Lavelle et al., 2015). All plants will rotate, except for the permanent crops, because they require time to flourish (Lavelle et al., 2015). Each year the gardener should move every group of vegetables to the following plot (Lavelle et al., 2015).

4.2.13 Plant Spacing

Taller plants might require staking or other support (Lavelle et al., 2015). In contrast, for root vegetation, digging deeper into the soil to plant carrots and potatoes will allow these root vegetables room to grow (Lavelle et al., 2015). Knowing the desired placement in a yard and the space required for the garden is an appropriate starting point for a food garden project. There are several different ways to arrange a food garden for growing. Planting in rows is a common choice because the plants can mature and flourish without competition from other plants for space but planting in rows does require more maintenance (Lavelle et al., 2015; Brock, 2019). When planning a garden with rows, it is important to consider that weeds can grow between the rows, thus requiring upkeep (Lavelle et al., 2015). Different plants have unique space requirements, and larger plants might produce fewer yields, thereby wasting space (Lavelle et al., 2015). The spaces between the rows allow for access to the plants allowing for weeding, watering, and harvesting (The Ontario Trillium Foundation, 2009).

Adequately spaced plants will have enough room to grow, and taller vegetables will not overshadow smaller ones (Brock, 2019). Avoid planting so close that the vegetation competes for food, sun, and water because this will result in smaller harvests with lower quality vegetables (Brock, 2019). Rows should be spaced according to plants' requirements and the equipment used (Ministry of Agriculture, Food and Rural Affairs, 2021). Onions, radishes and carrots do not generate big plants or leaves, and gardeners may plant them with a spacing of 30 centimetres (Ministry of Agriculture, Food and Rural Affairs, 2021). Beans, corn, and tomatoes should be planted with 90 centimetres of space between (Ministry of Agriculture, Food and Rural Affairs, 2021). If using a hoe, space can be minimized so the rows can be placed as close together as possible (Ministry of Agriculture, Food and Rural Affairs, 2021). Rows are maintained with

hoeing and allow for excellent airflow (Lavelle et al., 2015). Plants such as tomatoes, beans, cabbages, corn, potatoes, peppers, summer squash benefit from the space that planting in rows offers (Brock, 2019). Garden Rows that run north to south take advantage of more sunlight than gardens that run east to west (Ministry of Agriculture, Food and Rural Affairs, 2021).

Block planting is another garden arrangement wherein crops are grown in squares or rectangles (e.g., five plants by five plants). Block planting effectively uses the available space and results in higher yields as more moisture is retained and better weed control (Lavelle et al., 2015). However, block planting also results in poor airflow and high humidity, an ideal environment for plant diseases to flourish (Lavelle et al., 2015). The plants can also inadvertently dehydrate because the water can run from more densely packed plants and not penetrate the soil for the roots to absorb (Lavelle et al., 2015).

4.2.14 Planting Design

Succession planting involves planning a garden so that one crop is followed by another. In contrast, interplanting involves planting faster-maturing plants with slower maturing plants, so there is no competition for space within the garden (Brock, 2019). For example, peas mature faster than broccoli, so they are well-paired together (Brock, 2019). Planting gardens vertically can save on space when space is an issue, as well as trellising, fencing, or caging certain vegetables (Brock, 2019). One cucumber plant can take up to 4.5 metres, but one can have four plants in the same space by using a trellis (Brock, 2019).

4.2.15 Garden Bed Designs

Flatbeds are a ground-level bed design with potential challenges if the soil conditions are not great, leading to dry or water saturation conditions (Lavelle et al., 2015). The choices to resolve poor conditions include fixing the soil or building a raised garden bed (Brock, 2019;

Ministry of Agriculture, Food and Rural Affairs, 2021). If there are too many large rocks, establish the garden in an alternate area. Alternatively, make a raised bed because too many stones may prove to be a much more complex undertaking (Brock, 2019).

Raised and edged garden beds consist of freestanding garden beds or beds within wooden or brick walls designed to solve soil problems (Lavelle et al., 2015). Raised garden beds are built atop the ground using a wooden frame filled with a fertile soil mix, compost, and manure (Blackmore, 2017; Brock, 2019). Pressure-treated wood or creosote-treated railroad ties should not be used to build the raised beds due to chemicals that leech into the soil and plants (Brock, 2019; Murphy, 2018), defeating the purpose of what we are attempting to accomplish. Cinder blocks, stones, galvanized steel, and wood are preferred choices for creating raised beds as these materials can conform to an assortment of outlines and dimensions (Murphy, 2018).

Raised beds can be any size, and because they are not meant to be walked on, the soil remains light and fluffy (Blackmore, 2017; Brock, 2019; Murphy, 2018). The gardener can gain access to the centre of the bed from either side by limiting the raised bed's width to no more than 1.25 metres (Blackmore, 2017; Murphy, 2018). More extensive garden beds create more planting area, but this also increases the weight and challenges durability (Murphy, 2018). Rebar or stakes in the soil secured to the interior sides of the garden bed for vertical support will reduce the risk of beds bowing or flexing under the soil's pressure and weight as it expands and contracts with the changing seasons in zone 5b (Murphy, 2018). The raised bed's minimum depth should be 45 centimetres (Blackmore, 2017; Blackmore, 2017).

The soil in raised garden beds warms earlier in the springtime to allow for earlier planting (Lavelle et al., 2015; Brock, 2019). Smaller vegetables and root crops such as lettuce, beets, carrots, onions, spinach, and radishes thrive in raised beds (Brock, 2019). Raised beds can

resolve several problems because they define the space and aid in managing pests (Murphy, 2018). Raised beds are more comfortable to work in, as knees and back can rest while sitting on the side of the raised structure to reach into the garden bed (Brock, 2019; Murphy, 2018).

"No dig" gardens are another form of gardening (Lavelle et al., 2015). This alternative and productive method of establishing a garden is a "lasagna bed," which develops a growing area atop the existing ground, so no digging is necessary (Blackmore, 2017). Layers are created using organic materials such as grass clippings, leaves, seaweed, old straw, manure, or compost interfused with soil layers. Two thin layers are more valuable than one bulky layer as each layer has a distinct amount of nutrients for the plants (Blackmore, 2017). After choosing the garden bed area, gardeners should cover it with newspaper and then cardboard to prevent weeds and maintain moisture for the plants; this material decomposes it breaks down into organic matter for the garden (Blackmore, 2017). The layers of the lasagna bed are categorized as "green" and "brown," which alternate frequently and contain at least one layer of compost (Blackmore, 2017). Green layers consist of grass clippings, kitchen waste, or fresh plant material, while brown layers consist of straw, dead leaves, and soil (Blackmore, 2017). The top-level should be soil covered with straw or dried leaves to stop weed seeds from taking hold (Blackmore, 2017; Niemann, 2017). Lasagna beds should be set up in the fall or winter, so the layers have time to meld together into a rich, soft, growing space (Blackmore, 2017).

4.2.16 Watering

Water is another critical ingredient for a successful garden. While natural rainfall is beneficial for the garden, supplemental watering will be required unless an area has substantial precipitation (Lavelle et al., 2015). Plants require a minimum of 2.5 centimetres per week of water (Niemann, 2017; The Ontario Trillium Foundation, 2009), which gardeners can measure

using a rain gauge (The Ontario Trillium Foundation, 2009). Most regions cannot rely solely on natural rainwater as it is insufficient for the garden's needs (Murphy, 2018). Supplemental water is especially required for juvenile plants with shallow roots (Lavelle et al., 2015; The Ontario Trillium Foundation, 2009). Any plant that appears to be wilted or depressed should receive water as a first intervention (Råman et al., 2017; Brock, 2019). Remember that having the right kind of soil with plentiful organic matter and a top layer of mulch will allow the soil to retain water without drainage issues (The Ontario Trillium Foundation, 2009; Lavelle et al., 2015). Ensuring the soil is thoroughly soaked will guarantee that the water makes it to the plant roots and encourage deeper roots that are not as easily damaged (Lavelle et al., 2015).

The garden will most likely require supplemental water using a watering can or a hose with a gentle spray so nutritious soil does not get washed away (Lavelle et al., 2015). Sprinklers will douse the plants with water gently and effectively without much effort (Lavelle et al., 2015). Hose water from the house is an obvious choice, but it is not the only one. Rain barrels can be installed under a downspout on the property to collect water that would otherwise go to waste as it runs off the roof of the house (The Ontario Trillium Foundation, 2009; Lavelle et al., 2015; Brock, 2019). For example, 2.5 centimetres of rainfall hitting a 300 square metre roof can provide approximately 2300 litres of water (Brock, 2019). Rainwater catchment would require gutters to enable the water to drain into rain barrels and cisterns, screens to filter out leaves and other debris, hoses to drain the water from the barrels into the garden, and watering cans to dip into the barrels (Brock, 2019).

It is essential not to over or under water the garden, as this can cause the roots of the plants to die, leaving wilting and dying plants (Lavelle et al., 2015). Too little watering causes stunted growth, while too much watering will drown the roots (The Ontario Trillium Foundation,

2009). Ensure that the soil around the plants gets water and not just the leaves, where the water will not be absorbed by the roots and be lost (The Ontario Trillium Foundation, 2009).

Watering at the appropriate time of day is also important for the plants' survival, as watering in the heat of full sunlight can cause the plant to become scorched (Lavelle et al., 2015). Instead, choose to water the garden earlier in the mornings, so the water has a chance to absorb into the soil before the heat from the sun evaporates it before the plants can use it (The Ontario Trillium Foundation, 2009). Likewise, avoid watering on windy days as this can also evaporate the water prematurely (The Ontario Trillium Foundation, 2009). Watering the garden should be avoided at night due to an increased risk of plant diseases leading to plant rot (The Ontario Trillium Foundation. 2009). Providing established plants with a good soaking of water every 3 to 4 days should keep the garden growing and healthy and prevent the soil from drying out between watering (The Ontario Trillium Foundation, 2009; Brock, 2019). A garden needs water if a finger is inserted 2.5-5 centimetres remains dry (The Ontario Trillium Foundation, 2009; Brock, 2019). Germinating seeds and seedlings will require gentle watering once a day if there is no rainwater, while transplanted vegetation requires watering when first planted and every few days afterwards (Brock, 2019). Removing weeds from the garden will reduce competition for resources (The Ontario Trillium Foundation, 2009).

4.2.17 Containers

The gardener requires buckets for green refuse, trimmings, and gathering yields (Blackmore, 2017; Brock, 2019). Wagons, wheelbarrows or garden carts may be necessary to move around certain items around the garden, such as plants intended for transplant or heavy materials, such as soil and fertilizer (Brock, 2019). The major difference between wheelbarrows and garden carts is that wheelbarrows move around within tight spaces and can suddenly turn. In

contrast, carts have better balance, carry larger loads, and are easier to move forwards (Brock, 2019).

Calibrated watering cans can assist in watering a garden and be equipped with a removable perforated spout for easy cleaning if the holes become obstructed (Blackmore, 2017; Brock, 2019). An alternative to a watering can is a garden hose long enough to reach the garden without spraying water across a distance (Brock, 2019). Choosing the correct tools for the job will make gardening more manageable and cultivating homegrown food an increasingly attainable goal.

Food gardening is possible even if with limited space. Container gardening is a popular alternative to a spacious garden that still provides healthy food. The gardener can place containers on patios, roofs, balconies, windows, among other places (Lavelle et al., 2015; Murphy, 2018), such as walls, decks, fences, and anywhere a container can hang and receive sunlight (Murphy, 2018).

4.2.18 Growing Container Attributes

Gardening containers must have drainage holes in the bottom to allows excess water to drain away from the plant roots (Lavelle et al., 2015; Murphy, 2018). A larger container will hold more soil and moisture (Landscape Ontario Horticulture Trades Association, 2014). If there is available space, sun, and a container that allows for proper drainage, the conditions for a "garden" have been met (Murphy, 2018).

The gardener can convert an old washtub, a basket, an old trash can, or even a wine box into a growing container (Murphy, 2018). A container that can be manoeuvred around independently by lifting, carrying, pulling, or wheeling is a good fit in a space (Murphy, 2018). As plants get watered and supplements are introduced, the soil will become dense and have

fewer nutrients, so it is important to repot and change all soil, or at least a portion annually, especially with a smaller container of fewer than 37 litres (Murphy, 2018).

Potting soil is required for container gardening, but not garden soil as this will cause the container to become impacted, and water will not drain out correctly (Landscape Ontario Horticulture Trades Association, 2014). In places where space is especially limited, such as in an apartment, window boxes can be employed to grow fresh herbs and vegetables (Lavelle et al., 2015).

4.2.19 What to Grow in a Container

Potatoes grow well in barrels, herbs flourish in pots, and fruit trees can grow in decorative containers (Lavelle et al., 2015). Tomatoes, eggplants, bell peppers, cucumbers, small lettuce, zucchini, peas, and radishes are examples of edible plants that can thrive in a container garden (Landscape Ontario Horticulture Trades Association, 2014). Begin with a small-scale growing area to make it manageable, learn as you go, and cultivate what you like (Murphy, 2018). Container gardening is an inexpensive alternative to traditional gardens when traditional gardens are not an option.

4.2.20 Food Safety

When planting an organic food garden, gardeners should take a few precautions to ensure the food is safe to eat. Food safety begins at the planning stages of a new garden (Ministry of Agriculture, Food, And Rural Affairs, 2020). Just as not using materials treated with chemicals for raised beds (Murphy, 2018), other practices can also cause problems for homegrown food. Sources of harmful bacteria are insufficient quality water, pets, manure, wild animals, and poor personal hygiene practices (Urban Agriculture Business Information Bundle, 2020). Greywater, such as bathwater or dishwasher water, is not recommended for use on plants intended to be

eaten due to safety concerns (Lavelle et al., 2015). It is also essential to not ever plant a garden over the leach line of a septic system; otherwise, the food grown could be contaminated (Brock, 2019). Because the purposes of this endeavour are to prevent the ingestion of pesticides and other poisons, avoid using pesticides and other chemicals on your food.

4.2.21 Storage

After harvest, there are simple, chemical-free ways to prolong the shelf life and edibility of crops. Root produce can be cleaned, placed in sand, sawdust, fine leaf mould, bark or sterilized soil and stored in a cool, dark place (Lavelle et al., 2015). Brassicas can be left in the ground where they were grown and be harvested as required (Lavelle et al., 2015). Other vegetables can be stored on shelves or in containers, as long as they do not touch one another (Lavelle et al., 2015). The gardener can keep onions and garlic in open sacks, and cabbage can be kept in netting for up to three months (Lavelle et al., 2015).

4.2.22 Storage Area

The storage area where the gardener keeps harvested produce should be free of frost, pests, rain and maintain a constant, cool temperature with sufficient exposure to air, such as a dedicated refrigerator (Lavelle et al., 2015). Weekly inspections should be done, and vegetables showing signs of decomposition should be discarded (Lavelle et al., 2015). If multiple pieces of produce rot simultaneously, there is likely a storage problem, but remember that while frozen fruit loses firmness, it retains its taste (Lavelle et al., 2015).

4.2.23 Freezing and Canning

Some vegetables such as asparagus, beans, or cauliflower can be frozen after blanching in boiling water for a couple of minutes. Other vegetables can be preserved by cooking before freezing (Lavelle et al., 2015). Blanching destroys any bacteria on the plant and requires boiling

for one minute (Niemann, 2017). Top fruit (fruit that grows on trees) can be stored for most of the winter months, whereas stone fruits (fruit that contains a pit) and berries should be consumed, preserved, or frozen (Lavelle et al., 2015).

One crucial way to keep food edible for an extended period after removing it from the plant is to handle the food with care during and after harvest because it cannot repair itself (Lavelle et al., 2015). The gardener should only keep those crops of the best quality for storage, and any vegetables with broken skin, damage from pests, or disease should be used for freezing or preserving (Lavelle et al., 2015).

Fruits that cannot be stored for extended periods are better used in jams, pickling, and chutneys (Lavelle et al., 2015). Canning is an excellent way to preserve produce but is not within the scope of this paper. There are many safe ways to store vegetables that will preserve the crops and extend the food's life.

4.3.24 Pests, Weeds, and Plant Infections

Healthy plants will produce the most edible yield and keeping plants free of pests and infections is crucial for the garden's health. Applying insecticides both goes against this project's aim and exterminates the advantageous insects that keep a garden healthy (Niemann, 2017). It is important to remember that the gardener should expect some damage to plants in a garden, and minor issues with pests are not a cause for concern or necessarily require an intervention (Ministry of Agriculture, Food and Rural Affairs, 2021).

Some blemishes on produce are not worth the time, money, and effort that will be spent on pest control measures (Online Gardener’s Handbook 2010, 2010). You will find a list of common pests in Table 4.4. The best way to prevent pests from attacking crops is to keep plants healthy and frequently monitor pests (Ministry of Agriculture, Food and Rural Affairs, 2021).

Observing the growing plants at least weekly will allow for the early detection of harmful pests, and earlier interventions are more likely to be successful than are established and advanced infestations (Ministry of Agriculture, Food and Rural Affairs, 2021). The gardener can spray either Kaolin clay or soapy water onto the plants; these things have an unpleasant taste and prevent the plants from being eaten (Niemann, 2017). If insects are a real problem in the garden, keep one plant as a sacrifice, so the insects will attack just that one plant and leave the rest alone (Niemann, 2017). Pests can be prevented by staggering planting times because planting particular vegetables at specific times can avoid insects that are drawn to eat the vegetation—for example, planting seeds of the same vegetation a week or two apart to keep the plants at different growing phases (Niemann, 2017). The gardener can use row covers to keep the insects away from the plants while they grow, as long as the gardener removes all of the covers after blooming to allow for pollination (Niemann, 2017). Also, remember that plants in good physical shape are not as vulnerable to insect damage as are damaged or weak plants (Niemann, 2017). Keep records of the annual garden to become aware of the diseases and pests to be dealt with frequently (Lavelle et al., 2015). Pruning is a method to control diseases and pests by trimming off dead, diseased, and insect-damaged plants to allow other desired plants to grow alongside without all the plants encroaching on each other's space (Lavelle et al., 2015). The rotation of annual crops such as potatoes, carrots, cabbages, and beets can prevent diseases and pests in the soil (Lavelle et al., 2015).

Table 4.4. Common Pests

Pests	Description	Symptoms	Intervention
Snails and slugs	Slippery, legless, soft. Snails have an external shell, whereas slugs do not.	Nocturnal creatures that eat the leaves and plants	In the morning, pick them off and put them into the compost bin, where their efforts will be more appreciated
Aphids	Small, soft, pear-shaped, multicoloured insects	Suck the juices from plants	Pick them off and remove them from the garden, prune off infected areas
Earwigs	2 centimetres long, pincers at the back, reddish-brown	Eat seedlings, carrots, beets	Trap earwigs with multiple low-sided cans with bacon grease inside, dispose of them in the morning. Remove patches of weeds as earwigs live there.
Caterpillars	Long, furry bugs with many legs, multicoloured	Eat the leaves from the plants	Pick them off and put them away from the garden, such as the grass.
Weevils	White larvae resemble grubs	Found in the ground, will eat the roots of plants	Prune off the affected area and dispose.

(The Ontario Trillium Foundation, 2009; Ministry of Agriculture, Food and Rural Affairs, 2021)

Not all insects are harmful, or a cause for concern and most are advantageous in a garden (The Ontario Trillium Foundation, 2009). Table 4.5 lists some common helpful insects.

Table 4.5. Helpful Bugs

Bugs	Description	How They Help
Ladybugs	Red insects with black, symmetrical polka-dots on wings	Eat harmful bugs, such as aphids
Spiders	Eight legs, build webs to catch other insects	Provide an alternative food for birds, catch harmful bugs
Dragonflies	Long bodies, four wings	Eat harmful insects
Butterflies	Colourful insects with four wings	Pollinate
Bees	Yellow with black stripes, stingers	Pollinate

(The Ontario Trillium Foundation, 2009)

Weeds are a common problem in gardens, but the gardener can eliminate weeds with some time and effort. Weeds can kill unhealthier plants by taking nutrients and resources from the desired plants and acting as hosts for unwanted insects and diseases (Lavelle et al., 2015). The seeds for weeds can be in the ground, so when the gardener initially prepares the ground, they can ensure that the soil is appropriately cultivated to prevent the growth of weeds from the start (Lavelle et al., 2015). Fallowing is a method of allowing the soil to sit for weeks to months to pick out any weeds that are growing before planting desired crops (Lavelle et al., 2015). If weeds start to grow in the garden, the gardener can use a garden hoe to destroy the roots and remove the plant (Lavelle et al., 2015). After establishing the garden, weeding frequently prevents unwanted plants from causing problems (Niemann, 2017).

Insects are not the only pests that can threaten a garden. Rabbits will claim smaller territories approximately 0.04 square kilometres, live in trees, brush piles, under buildings, or abandoned burrows, and will eat almost any plant all day, every day (Brock, 2019). The damage to the plant appears as clean, angled cuts made by the rabbit's upper and lower front teeth (Brock, 2019). Rounded or somewhat flattened droppings also signal the presence of rabbits. Gardeners can fence rabbits out with an underground chicken wire setup that goes 15 centimetres underground that angles into a right-angle facing outward and goes to 122 centimetres high (Brock, 2019). After obtaining dog or human hair from professional hair salons or animal groomers, place the hair around the garden to act as a natural deterrent, putting more out every few weeks (Brock, 2019).

Groundhogs are slow-moving animals that live in underground tunnels that spread as far as 21 metres and have several entrances (Brock, 2019). The hallmark of a groundhog is its home, which comprises a pile of dug-out dirt adjacent to a 30-centimetre-wide hole (Brock, 2019).

Groundhogs tend to remain approximately 30 metres from their burrows, which they leave in the mornings and evenings searching for food (Brock, 2019). Groundhogs enjoy eating beans, squash, peas, brassicas, different seedlings, and woody plants (Brock, 2019). The best way to keep groundhogs away from crops is by erecting a fence 152 centimetres high and buried 45 centimetres underground, with the top of the fence bent outward, so when scaling the fence, the groundhog falls backwards and is unable to reach the vegetation (Brock, 2019). If the groundhogs are particularly tenacious, the gardener can establish two strands of electrified fencing 12 and 20 centimetres from the landscape (Brock, 2019). Groundhogs also dislike hot pepper wax, which the gardener can use as a disincentive (Brock, 2019).

Raccoons are known to eat anything and are especially fond of fruit, corn and will dig up a garden to search for grubs (Brock, 2019). Raccoons can be controlled by establishing motion detector activated sprinklers, lights and managing the grub population, providing less to eat in the garden (Brock, 2019). A fence, either electrified or regular mesh, will prevent these animals from entering the garden. Ideally, the fence stands 152 centimetres tall and 30 centimetres below the ground, curving away from the garden while leaving the top 45 centimetres free from support poles so the raccoons cannot easily climb over the top (Brock, 2019).

Squirrels are nimble and confident in stealing garden crops, and they eat fruits, nuts, berries, seedlings, bark, and softball-sized tomatoes (Brock, 2019). Because squirrels are abundant, they are permanent members of the yard and can be deterred by spraying unpleasant-tasting substances on the plants or implementing motion-activated sprinklers (Brock, 2019). To prevent any creatures from stealing seeds from the garden, cover newly planted garden beds with chicken wire, and the plants will develop through the holes in the wire (Brock, 2019).

Birds tend to eat helpful garden insects and feast on tomatoes and berries (Brock, 2019). A bird tunnel made of mesh over the garden, or a floating row cover can prevent birds while still allowing sunlight to reach the plants (Brock, 2019). Birds are startled by noises, fluttering objects, and anything that simulates an animal of prey but remember that birds are quick learners and will not remain afraid for long (Brock, 2019). Some ideas for deterring birds include tying strings to stakes and displaying aluminum pie plates or reflective media discs around the garden's boundaries, creating noises and light (Brock, 2019). Flash or scare tape will also work, as will balloons and kites with imagery reminiscent of predators such as owls or hawks (Brock, 2019). With the several different kinds of animals and birds that can hinder a garden, there are many interventions to choose from once the gardener has identified the pests.

Plant diseases can be a cause of damage to produce and decreased yields. Knowing how to recognize and treat common plant diseases can save crops and increase edible food production (Ministry of Agriculture, Food and Rural Affairs, 2021). There is a list of common plant diseases and interventions in Table 4.6.

Table 4.6 Common Plant Diseases

Plant Disease	Description	Intervention
Bacterial Soft Rot	It can happen in either the garden or in storage. Bacteria enter the crops through imperfections, causing a fast-moving, soggy rot	Because this happens with excess water, ensure there aren't drainage issues, the plants aren't crowded and remove infected plants
Viral Diseases	Misshapen leaves, flowers, and crops	Plant resistant selections of crops, remove aphids as they carry viruses
White Mould	Leaves, stems, pods turn brown and decay, producing masses of white cottony clusters with black dots	Remove and discard any affected plants and fallen leaves immediately. Give plants enough space when sowing seeds.
Wilt Diseases	Found in hot, dry weather. Attacks the roots, preventing water and nutrients from going up the stem and reaching the rest of the plant. Plant wilts and dies.	Remove and discard any affected plants. Disinfect gardening equipment. Do not plant susceptible plants in that spot for multiple years.

(Ministry of Agriculture, Food and Rural Affairs, 2021)

4.3 Objective 3: Community Supports

Identifying community supports to support a completely organic diet is an important facet of assisting people to avoid the ingestion of pesticides. Even grocery store-bought produce can have trace amounts of pesticides within the plant if the soil was ever contaminated with the chemicals. In Peterborough, Ontario, there are three farmer's markets. The Peterborough Farmer's Market was established 190 years ago, the Peterborough Downtown Farmer's Market was established in 1997, and the Peterborough Regional Farmer's Market was established within the last few years. These farmer's markets offer locally grown farmers an opportunity to sell their produce directly to the consumer. Several vendors claim to be organic. Talking to these vendors can aid in assisting a person with a pesticide aversion to eat a complete diet of

vegetables and fruits even when gardening is not possible, in the off-season, or if the garden did not produce enough food to sustain nutritional value requirements. These community supports can and be used for those concerned about pesticide use on their food.

CHAPTER 5: DISCUSSION AND CONCLUSIONS

In this chapter, I refer to the model case from Chapter 1 to discuss the global issue of wellbeing indices and reflect on the gardening response to the COVID-19 pandemic. I also include implications for nursing practice, nursing, education, and nursing research. There were some challenges presented when creating the brochure, and I discuss this in detail. Recommendations are available for families who want to create a food garden based on the information gathered from this paper.

5.1 The CIW and CHNs

The brochure produced for this project can guide how CHNs teach clients about health, nutrition, and working to eliminate pesticides from the diet. The CIW (2016) was applied to the gardening brochure to through community vitality, healthy populations, leisure and culture, living standards, and time use. Community vitality is encouraged in the brochure by inspiring people to be outside and possibly meet their neighbours, make new friends, and share the food that is grown in the garden. The brochure aims to educate people on eating healthy vegetables and fruits from the garden, creating more healthy populations. The CIW promotes healthy populations by aiming to improve the physical, mental, and social wellbeing of members of the population by examining lifestyle and behaviours (CIW, 2016). People can garden for leisure and cultural practices and increase living standards by potentially alleviating food insecurity.

The COVID-19 pandemic caused sudden and drastic worldwide changes to the way of life, food supplies, and food security. Job losses and a hard-hit economy caused food insecurity amongst Canadians. Citizens were afraid to go out in public for fears of contracting the disease. The brochure developed can be given to individuals living in Peterborough, Ontario, to alleviate

financial and food insecurity issues. Gardening can be a positive use of one's time and create health advantages that otherwise would not be experienced.

5.2 Lewin's Three-Step Model for Change

Lewin's (1947) Three-Step Model for Change guided this brochure by allowing for unfreezing, changing/moving and refreezing. The example family in the model case exemplify the process of Lewin's theory. When the family visits the doctor and the PFHT and determines that the daughter is suffering from a probable food intolerance, they experience unfreezing. Their lives had been static with visiting the same grocery store for food for 10 years. A change was recognized to be necessary. The family was seeking ways to re-establish balance to their lives. Changing/moving occurred when the family received training and coaching from the dietician and the community health nurse about Canada's Food Guide and establishing a backyard garden for nutrition. The parents also sought knowledge about gardening for food from the library, the internet, and acquaintances who garden. Refreezing occurred when the family was able to vegetable garden and feed their family healthy, nutritious food without relying on the grocery store, thus returning to a life balance with the implementation of new habits. This model case embodies Lewin's theory to show how changing circumstances can lead to changing behaviours.

5.3 Implications for Nursing Practice and Research

Gardening for nutrition to alleviate food challenges and mitigate chronic conditions is a topic that nurses can address. CHNs can understand and disseminate this information on how to garden, specifically in Zone 5b for families who are interested in having a more active role in their food autonomy. Managing chronic illnesses is crucial for the health of the population, and education surrounding nutrition would be beneficial for optimizing health. Gardening topics might be new for CHNs, and the information in this brochure can prove helpful for educating

both nursing staff and clients alike. CHN standards of practice state that it is the job of the CHN to assist clients in translating and handling health information to maximize their health where they live and working at high levels of autonomy (Community Health Nurses of Canada, 2019 p. 12). It would be appropriate for CHNs to review the information in this brochure, educate themselves about food production, and assist clients with their household food self-sufficiency aspirations. This information brochure can be given to the PPHU and PFHT for doctor's offices and public health nurses, dieticians, and other healthcare teams to assist clients in achieving better health, nutrition, and symptom management.

The recommendations for families who want to have more control over their food are contained within the brochure. The example family from the case study required additional control over food choices above and beyond the grocery store, and gardening for nutrition was a solution that assisted with the issue. Recommendations for eating proper nutrition according to Canada's Food Guide, how to decide where the garden should be, what it should look like, how to get adequate soil, what to plant and when, what to do about pests, what gardening tools are required, and how to troubleshoot fundamental gardening issues are all contained within the brochure. The example family from the case study had concerns regarding following Canada's Food Guide, and healthcare professionals assisted in teaching the family how to eat the recommended daily intake of vegetables and fruit. This information should be enough to allow novice gardeners to initiate gardening procedures and establish a basic garden for food production, such as the example family from the case study. Further information regarding more advanced gardening procedures can be found online, with resources contained within the brochure. A follow-up brochure could be produced later with more advanced gardening techniques and issues novice gardeners may encounter.

A brochure model was chosen rather than a podcast or video because a brochure is printable, accessible without technology, and, for some people, easier to understand. This brochure can be given out as a physical hard copy or a PDF by the PPHU and PFHT or imbedded electronically for download, so if a hardcopy model is not desired by the individual using it, they can have the digital version. The information written down can be taken directly into the garden area and the pictures compared to what is viewed in the garden. The brochure can be taken to the gardening stores to observe the different tools to choose the correct instruments for the tasks at hand. In the future, a video or podcast could be made to fit more forms of media and potentially reach a wider audience. Webinars can be created and presented to spread this information to many people, perhaps wider reaching than just zone 5b. Generic, widespread material can be given for gardening. The information can be disseminated for how to find specific gardening instructions for individual climate zones.

5.4 Limitations

A lack of peer-reviewed literature limited this paper. After extensive searching, I could find no peer-reviewed information through scientific journals about gardening for nutrition. The information for "how-to" gardening was exclusively grey materials and lay literature in the form of multiple gardening books and government websites. Government websites were searched and utilized with up-to-date information. The brochure created was also limited by not consulting external sources due to the pandemic. If such feedback had been obtained, it would have been beneficial to discover how novice gardeners viewed the information with ease of reading and understanding, what negative feedback would be obtained, and what the opinions would be of creating a food garden with a person who had never taken up the practice. It would be interesting to discover how different demographics viewed the brochure through different lenses and

perspectives. Physical resources from the library were more challenging to obtain with pandemic restriction on entering the library. The brochure was not formally assessed and reviewed by the public due to time restraints and the COVID-19 pandemic. Acquaintances of the author examined the brochure and provided informal feedback. Such feedback included positive responses about the colours and pictures, appropriateness of the information, and ease of reading. Additional feedback indicated there was insufficient information regarding animal pests, soil, and Facebook groups. The collection of formal feedback and data for the brochure is planned for after the pandemic. In order to properly assess the brochure and the impact it might have, formal, sanctioned feedback will be required. Family dynamics might have to be assessed for the implementation of the brochure, such as how the family as a whole feel about the garden, and if there is any resistance to participation. Household food self-sufficiency can be assessed at a later date to determine how much food can be grown by a family in a single growing season. Issues behind food storage and preservation can be addressed at this time. It was determined that animal pests, while occasionally an issue for gardeners, did not fit in the 6-page space format for a concise brochure. The basics of soil and getting started were mentioned. Social media resources such as Facebook are inappropriate for this project as the information is not regulated and may not benefit the novice gardener. It was also suggested to remove how to buy seeds from the brochure to save room, but finding seeds is a fundamental element in the brochure for the novice gardener. This brochure is limited to being published in English and is only relevant to community members wanting to establish a backyard garden for nutritional purposes within Zone 5b. The information contained within this brochure is currently applicable but may require revisions based on climate change issues. This brochure is meant to be distributed to community members who wish to establish a backyard garden and consult the PPHI, PFHT or find the

electronic information independently. This brochure is designed to educate novice gardeners on the practices of establishing a garden, and more advanced gardening issues were not addressed in this brochure. This project contributes to nursing knowledge by providing CHNs with information not typically seen in nursing, to assist community members with living their healthiest lives possible.

APPENDIX A: GARDENING FOR NUTRITION BROCHURE

By Connie Myles

Vegetable Gardening
For Climate Zone 5b

BACKYARD GARDENING IN PETERBOROUGH

A how-to guide to growing organic, pesticide-free vegetables and fruits in Peterborough, Ontario.

Includes topics on:

- Healthy eating and nutrition
- Planning the garden, what to plant, and common problems
- Community resources

"We should all be eating fruits and vegetables as if our lives depend on it – because they do." - Michael Greger

The Importance of Nutrition

Not eating enough fruits and vegetables causes health problems. Being overweight is largely caused by a bad diet. When children are raised with greasy, unhealthy foods they grow up to crave unhealthy foods and not eat nutritious foods as adults. Canada's Food Guide says that eating the right ratios of vegetables and fruits, grain products, and protein will help to meet a the body's daily needs of vitamins, minerals, and other nutrients. Half of the food on a person's plate should be fruits and vegetables, one-quarter of the food should be whole grains, and the last quarter should be protein. This will reduce the risk of obesity, type 2 diabetes, heart disease, some cancers, and give a feeling of general well-being and vitality.

Fruit and vegetable gardening benefits both adults and children alike by increasing the amount of fruits and vegetables eaten and giving them more nutrients the body can use to be healthy.

Gardening for Nutrition

Think of how much space you have, how you want the garden to look, what you would like to grow, and how much food you want to have. Planting in rows is a popular garden layout because it gives the plants room to grow. Be sure to pull out any weeds found within the garden and between the rows.

Plants need:

- Sunlight—At least 6 hours of sunlight every day
- Water
- Space to grow. Carrots and potatoes will need to have room to grow underground so it is necessary to dig deeper.

Soil for planting should not be too thin and sandy, or too thick like clay. The best soil for gardening is loam. When you squeeze loam soil in your hand, it stays together after letting it go, it but falls apart easily. The easiest way to make a loam soil is to add compost., or buy an organic mix of topsoil and compost with ratios of either 60:40 or 50:50.

Flat beds are common gardens that are made on the ground. "Lasagna beds" are a popular way to make a garden. Start by putting down a layer of newspaper, and then a layer of cardboard to stop weeds and other plants from growing into the new garden. Then start layering the soil with organic materials like:

- Grass clippings
- Leaves
- Seaweed
- Old straw
- Manure
- Compost—at least one layer in the lasagna

Thinner layers give the plants lots of nutrients. On the top of the lasagna it should be soil that is covered with mulch to stop weeds. Lasagna beds should be set up in the fall or winter so that the layers have time to settle together into a rich, soft, growing space.

Sources of mulch should never contain plastic materials. Mulch can be:

- Wood chips
- Grass clippings
- Straw

Tools of the Trade

Water must be available for the garden. While natural rainfall is good, extra watering will be needed with hoses or watering cans. Any plant that looks wilted or sick should be watered immediately.

Spades and shovels may look similar, they do different things. Spades are meant for digging as they have sharper blades, while shovels are meant for moving around soil, compost, etc. Think of it like a snow shovel.

Hoes are used for gardening in rows, cutting and removing weeds, and making spaces for the seeds to be planted.

Hand trowels are used for mixing soil, creating holes for planting, and digging close to the plants without harm. They are the best tools for digging in containers, window boxes, and smaller gardens.

Gardening rakes break up soil and smooth seed beds.

Rubber kneeling mats will prevent sore knees. A pair of well-fitting gardening gloves with rubberized palms will protect the hands.

Wearing a sun hat, long sleeves and sunblock will prevent sun damage, and gardening shoes or boots will keep feet safe.

Gardening tools can be purchased can be purchased at garden centres across Peterborough, for example:

- Canadian Tire
- Johnston's Greenhouse & Landscaping
- Home Depot

Common Garden Pests

Pests	What It Looks Like	Symptoms	What To Do About It
Snails and Slugs	Slippery, legless, soft. Snails have an external shell where-	Nocturnal creatures that eat the leaves and plants.	In the morning, pick them off and put them into the compost bin where their efforts
Aphids	Small, soft, pear-shaped, mul-ticoloured insects.	They suck the juices from the plants.	Pick them off and remove them from the garden, prune off infected areas.
Earwigs	2 centimetres long, pincers at the back, reddish brown.	Eat seedlings, carrots, beets.	Trap them with multiple low sided cans with bacon grease inside, dispose of them in the morning. Remove patches of weeds
Caterpillars	Long, furry bugs with many legs, multicoloured	Eat the leaves from the plants.	Pick them off and put them away from the garden, such as the grass.
Weevils	White larvae, resemble grubs.	Found in the ground, will eat the	Prune off the affected area and remove.

Garden Resources

You can get plants either by planting seeds or buying "transplants" from the garden store. Transplants are plants that have already started to grow, and can be planted in your garden. It is cheaper to buy seeds than transplants. Seeds and transplants can be purchased at garden centres across Peterborough, for example:

- Canadian Tire
- Johnston's Greenhouse & Landscaping
- Local garden enthusiasts https://urbantomato.ca/

Online seeds can be purchased at:

- https://www.oscseeds.com/
- https://www.stokeseeds.com/ca/

What To Plant, and When:

Planting Seeds

Seeds	Distance Between Plants	Planting Depth	Seed Planting Dates
Bush Beans	5-8 cm	4—5 cm	May 5—June 15
Beets	3-5 cm	1.5 cm	April 20—June 1
Broccoli	45-60 cm	0.5—1.5 cm	May 5—July 15
Carrots	3-5 cm	1.5 cm	April 15—June 1
Cucumber	30-60 cm	1.5—2.5 cm	June 1– June 10
Kale	60 cm	0.5 cm	April 1—June 1
Lettice (Head)	30cm	0.5—1 cm	April 1—10; and June 25—July 5
Potato	25—30 cm	10 cm	April 5—June 1
Radish	2.5 cm	1.2 cm	April 1—May 1; and August 1—September 1
Squash	60—120 cm	2—3 cm	May 25—June 10
Thyme	15 cm	0.5-1 cm	May 10 to May 30

Transplanting Plants

Transplant	Distance Between Plants	Transplanting Dates
Broccoli	45-60 cm	April 25—May 5 for early or June
Brussels Sprouts	60 cm	April 5—April 25
Cucumber	30-60 cm	June 10—June 20
Lettuce (Head)	30 cm	April 1—April 20
Peppers	60 cm	June 1—20
Rhubarb	90 cm	April 14—May 1
Tomatoes	90 cm	May 15—June 16

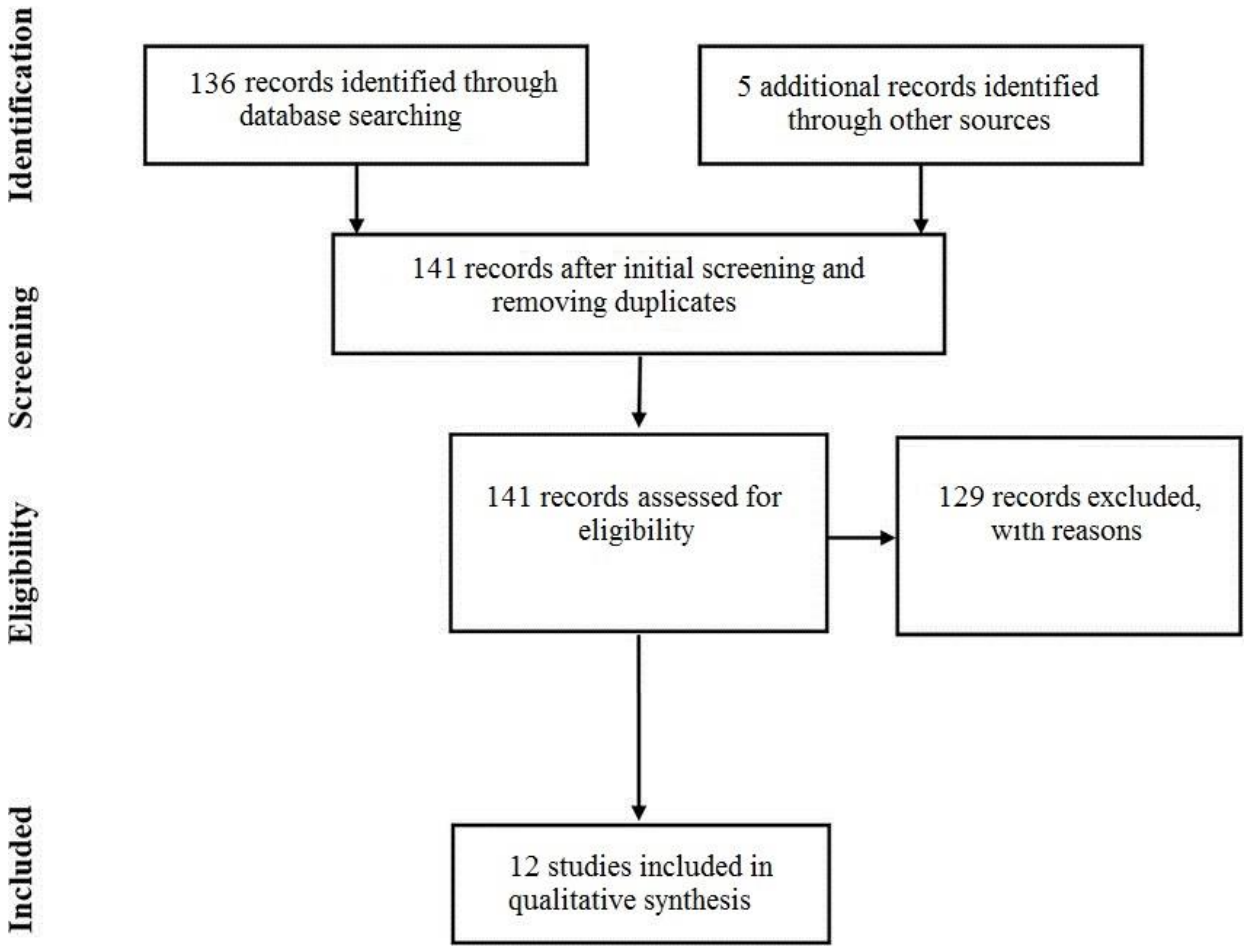
Help In The Community

Finding help in the community to avoid pesticide use is important for eating a completely organic diet. Even organic food from the grocery store can have some amounts of pesticides inside the plant if the soil had ever been treated with chemicals. In Peterborough, we have three farmer's markets within the borders of our city. The Peterborough Farmer's Market was established 190 years ago, the Peterborough Downtown Farmer's Market was established in 1997, and the Peterborough Regional Farmer's Market was established within the last few years. Many vendors claim to be organic, and talking to these vendors directly to establish a rapport can help people to eat a full diet of vegetables and fruits even when gardening is not possible either in the off season, or if the garden simply did not grow enough.

Not Just For Nutrition

Not only does gardening help with giving people and families fresh, low-cost food, but it has other benefits as well. Having a home garden can give the gardener some physical exercise and improved mental health. Lots of people find gardening relaxing, and you can relieve stress by making your own nutritious food and saving money at the grocery store at the same time. Gardening also helps neighbours to get to know each other better. If people are outside working in their garden, they might be able to talk to people in the neighbourhood that they otherwise would not get to know by staying inside their house. Imagine making new friends out of your neighbours by planting a food garden. Families can spend quality time together working with the garden. Family bonds can be improved by working together toward a common goal. If you grow enough food, you can share it with others who may benefit from some garden fresh vegetables, helping your community while you make positive changes in you and your family's lives.

APPENDIX B: PRISMA FLOW CHART



APPENDIX C: CHAPTER 4 RESOURCES

Author(s)	Publication Year	Purpose	Type of Literature	Major Themes
Blackmore	2017	Teaches how to take control of food through gardening	Qualitative Gardening Book	Avoiding pesticides, an in-depth, how-to guide to planting, growing, harvesting, cooking and preserving food.
Brock	2019	Teaches how to be food self-sufficient through gardening	Qualitative Gardening Book	All-encompassing information for homesteading includes establishing, maintaining a backyard food garden, preventing insect and animal pests, preserving food, promoting healthy living.
Landscape Ontario Horticulture Trades Association	2014	Information on how to start a food garden	Qualitative Website	Starting a garden for food, even with limited space.
Lavelle, et al	2015	Starting and maintaining a backyard garden	Qualitative Book	In-depth how-to book for the basics of gardening and harvesting. Half of the book is how to grow the food, and the other half is recipes to cook the food.
The Mel Bartholomew Foundation	2017	Maximizing yields	Qualitative Book	The Mel Bartholomew method of maximizing yields is a specific way to set up, organize, harvest, and consume the food grown in a garden. This book is specifically focused on maximizing yields and preventing food waste.
Murphy	2018	Makes gardening as simple as possible	Qualitative Book	Sees gardening as a personal experience and a work of art and a personal connection to

				the Earth. Very helpful and informative.
Niemann	2017	Grow your own food for health reasons	Qualitative Book	Very concerned with the health aspect of gardening. The view being everything should be homegrown and handmade because of chemicals changing our bodies and making children and adults sick. In-depth look at gardening.
Ministry of Agriculture, Food and Rural Affairs: Fruit Trees in the Home Garden	2021	Growing fruit trees in Ontario	Qualitative Government Website	An all-encompassing guide to establishing, maintaining, and maximizing yields for fruit trees in Ontario.
Ministry of Agriculture, Food and Rural Affairs: Online Gardener's Handbook	2021	How-to garden in Ontario	Qualitative Government Website	Extremely in-depth, step-by-step guide to establishing, problem solving, growing, planting, harvesting a food garden in Ontario.
The Ontario Trillium Foundation: Plant a Row Grow a Row	n.d.	General information about gardening	Qualitative Website	Step-by-step guide with lots of information about how to establish and maintain a backyard garden, discussing, soil, tools, pests, etc.
Kate Bradbury Pollination for Vegetable Gardens	2010	Pollination	Qualitative Website	In-depth detail about how pollination occurs, and what is required for successful pollination.
Råman et al.	2017	Soil	Qualitative Book	Everything to do with soil. Compost, mulch, sandy, clay, loam, nutrients, etc.

APPENDIX D: AACODS CHECKLIST

AACODS		YES	NO	?
Accuracy	• Does the item have a clearly stated aim or brief? • If so, is this met? • Does it have a stated methodology? • If so, is it adhered to? • Has it been peer-reviewed? • Has a reputable authority edited it? • Supported by authoritative, documented references or credible sources? • Is it representative of work in the field? • If No, is it a valid counterbalance? • Is any data collection explicit and appropriate for the research? • If the item is secondary material (e.g. a policy brief of a technical report), refer to • the original. Is it an accurate, unbiased interpretation or analysis?			
Authority	Identifying who is responsible for the intellectual content. Individual author: • Associated with a reputable organization? • Professional qualifications or considerable experience? • Produced/published other work (grey/black) in the field? • A recognized expert, identified in other sources? • Cited by others • Higher degree student under "expert" supervision? Organization or group: • Is the organization reputable? (e.g. W.H.O) • Is the organization an authority in the field? In all cases: • Does the item have a detailed reference list or bibliography?			
Coverage	All items have parameters that define their content coverage. These limits might mean that a work refers to a particular population group or excluded certain publication types. A report could be designed to answer a particular question or be based on statistics from a specific survey. • Are any limits clearly stated?			
Objectivity	It is important to identify bias, particularly if it is unstated or unacknowledged.			

	• Opinion, expert or otherwise, is still opinion: is the author's standpoint clear? • Does the work seem to be balanced in presentation?			
Date	For the item to inform your research, it needs to have a date that confirms the relevance • Does the item have a clearly stated date related to content? No easily discernible date is a strong concern. • If no date is given but can be closely ascertained, is there a valid reason for its absence? • Check the bibliography: have key contemporary material been included?			
Significance	This is a value judgment of the item in the context of the relevant research area • Is the item meaningful? (this incorporates feasibility, utility and relevance) • Does it add context? • Does it enrich or add something unique to the research? • Does it strengthen or refute a current position? • Would the research area be lesser without it? • Is it integral, representative, typical? • Does it have an impact? (in the sense of influencing the work or behaviour of others)			

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